Jefferson County

WRIA 17 Water Supply Storage Alternatives Analysis

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Water Supply Storage Alternatives Analysis
WRIA 17 - Eastern Jefferson County

October 31, 2003

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Acronyms

Ac-ft	Acre feet
ADD	Average day demand
ASR	Aquifer storage and retrieval
CDM	Camp Dresser and McKee
cfs	Cubic feet per second
City	City of Port Townsend
CT	Contact time
gpd	Gallons per day
GIS	Geographical Information System
gpm	Gallons per minute
MG	Million gallons
mgd	Million gallons per day
OGWS	Olympic Gravity Water System
PDD	Peak day demand
PTPC	Port Townsend Paper Company
PUD	Jefferson County Public Utility District
UGA	Urban growth area
USGS	US Geological Survey
WRIA	Water Rights Inventory Area

Section 1 Summary

1.1 Introduction

This project was undertaken as a part of the watershed planning efforts in Water Resource Inventory Area (WRIA) 17, which comprises eastern Jefferson and Clallam counties. The goal of the effort was to identify and evaluate potential means by which currently authorized amounts of water could be diverted, captured, recovered, reused, stored, or otherwise utilized more effectively and efficiently. Specifically, this effort was targeted to supplement current supplies during drought or low flow periods, in or near the vicinity of Port Townsend, and what is referred to as the "Tri-Area" of Jefferson County.

Although not a part of the project's initial scope, an additional task was defined by the WRIA 17 Planning Unit following a workshop. The nature of this task was to identify water supplies (both surface water and ground water) that might be used to supplement natural stream flows to potentially improve anadromous and native fisheries production and habitat conditions in the Big and Little Quilcene River watersheds. This effort, however, was not conducted with the benefit of analyses demonstrating water needs for fish, either in quantity of quality.

1.2 Key Findings and Recommendations

While this investigation has been commonly referred to as a "storage analysis," it has not been limited to include only surface water storage options. Other water supply alternatives have also been explored, such as conservation, reuse, operational modifications to existing delivery systems, and aquifer storage and retrieval. A total of six surface water storage options were analyzed and compared against these other types of water supply enhancements. Table 1-1 provides a summary of all alternatives considered. Overall, these water supply alternatives, including storage, represent only elements of water resource management in Jefferson County; they should not be considered complete resource strategies by themselves. Details regarding each option are provided in later sections of the report.

The following action steps are recommended as the WRIA 17 Planning Unit works toward the objectives stated above.

1. ***Take the Port Townsend Paper Company (PTPC) power generating turbine offline when PTPC and the City of Port Townsend (City) begin to withdraw Lords Lake storage without any refilling.*** This refers to shutting down the turbine immediately when storage begins to be withdrawn without being replaced by flows from the river. This is an activity that can currently be implemented and will optimize the use of Lords Lake storage in meeting PTPC and City needs during low flow periods.

Table 1-1
Summary of Water Supply Alternatives

Option	Water Provided or Saved During Low Flow Period (MG) (1)	Estimated Cost per MG	Feasibility of Implementation
Conservation/Reuse			
Jefferson County PUD	11	NA (2)	Moderate
City of Port Townsend	3-5	NA (2)	High
Port Townsend Paper Company	103	$4,000	Moderate
Conjunctive Use(3)			
Use of PUD's existing wells	73	$82,000	Low
Use of newly developed wells	73	$55,000	Moderate
Operational Modifications (4)	0	NA	High
Additional Surface Water Storage(5)			
Penny Creek	84	$14,000	Moderate
Lords Lake Enlargement	80	$12,000	High
City Lake Enlargement	97	$12,500	High
Off-Channel Excavated Lake	81	$19,000	Moderate
Natural Lake	91	$14,500	Moderate
Run-of-River, On-Channel	81	$62,000	Low

Notes: MG = million gallons; NA = Not Applicable

(1) "Low Flow Period" defined as being two months (60 days) long, during late summer/early autumn. In general, during drought years there is a need of approximately 50-110 million gallons of water in excess of what can be provided by existing sources of supply in the area.

(2) Cost estimates were not developed for conservation and reuse activities that might be implemented by the PUD and Port Townsend in the future, since there are a variety of activities that may be used (some of which have little cost and others which have significant costs) and due to the fact that conservation and reuse alone do not appear adequate to provide sufficient additional water supplies.

(3) Conjunctive use involves the use of surface supply when such supplies are plentiful (i.e., during high flow periods) and the use of ground water supplies during low flow periods. In order to conjunctively use the PUD's existing wells, additional iron and manganese treatment facilities would be required, as would filtration on the surface water supply conveyed to the Tri-Area from the Olympic Gravity Water System. The use of newly developed wells farther up in the watershed may negate the need for ground water treatment; however, well drilling costs would be added to the still remaining need to provide surface water treatment for water conveyed to the Tri-Area. These items are the primary elements of the cost estimates.

(4) This refers to installation of new valves and telemetry on the Olympic Gravity Water System to reduce overflows and more efficiently operate the system throughout the year. Benefits would be realized during high flow periods, as overflows would be reduced; however, benefits are negligible during low flow periods.

(5) Potential environmental impacts related to surface water storage projects include:

- degradation or removal of wildlife habitat
- degradation or removal of wetlands
- degraded water quality during construction

2. ***Identify target stream flows and periods of time when augmented flows in the Big Quilcene River would potentially enhance fisheries and fish habitat.*** While the City and PTPC currently operate the Olympic Gravity Water System so as to maintain a flow of at least 27 cubic feet per second in the Big Quilcene River, no formal determinations have been made as to the magnitude and timing of additional flows (as could potentially be provided by additional storage) that would be beneficial to fish and aquatic habitat. Such information would help to shape the planning and design of future storage.
3. ***Investigate more closely the concept of additional ground water development.*** There are many potential benefits associated with the conjunctive use of ground water and surface water supplies. Upon completion of a pending US Geological Survey (USGS) assessment of ground water in Eastern Jefferson County, the Planning Unit should consider investigating this option further, focusing more narrowly upon any potential aquifers identified in the USGS study.
4. ***Revisit the option of construction of additional storage.*** Storage needs should be more refined and focused as a result of the determination of fish needs and the feasibility of additional ground water development. It is recommended that the Planning Unit then revisit the storage options presented in this report. In particular, the two options most worthy of further review are the Lords Lake expansion alternative (as it is the most inexpensive) and the Penny Creek storage alternative (as it provides the greatest direct benefit to fisheries and fish habitat, due to the ability to release flows directly back into the Big Quilcene River system).

Section 2
Background

It has been an occasional occurrence for diversion of water from the Quilcene River system to cease during the dry part of the year, August through October, and a common occurrence for the Little Quilcene River, in order to maintain river flows. However, supply to the City of Port Townsend (City) and the Port Townsend Paper Company (PTPC) mill has been maintained with raw water storage in the system (Lords Lake and City Lake).

In 2002, an unusually dry late summer period forced PTPC to curtail operations by reducing the production of pulp and paper (Bremerton Sun, November 1, 2002) for two weeks, as reliance upon storage alone was not adequate to meet water demands and leave sufficient water in the Big Quilcene River for fish and habitat. PTPC is Jefferson County's largest private employer, currently employing approximately 350 people. This event resulted in a temporary loss of about 20 jobs (and mill profit loss) for the two week period, and has raised concerns about long-term supply in the area for both fish and people (environment and economy).

As part of the watershed planning efforts in Water Resource Inventory Area (WRIA) 17, a "storage" study was commissioned to examine what measures might be available to overcome these types of shortages in the future, while perhaps also bolstering instream flow levels during critical times. Funding for the evaluation was provided under a Washington State Department of Ecology grant.

The purpose of this project is to evaluate storage, and other water supply alternatives, as options for reducing the likelihood of water shortages in eastern Jefferson County. The focus of this effort has been on the area's two largest water purveyance systems: one serving the City and PTPC, and the other serving the Tri-Area (Chimacum, Irondale, and Hadlock, along with Indian and Marrowstone Islands).

Section 3
Objectives/Approaches

The goal of this study was to identify and evaluate potential means by which currently authorized amounts of water could be diverted, captured, recovered, reused, stored, or otherwise utilized more effectively and efficiently. Specifically, this effort was targeted to supplement current supplies during drought or low flow periods, in or near the vicinity of the City of Port Townsend (City), and what is referred to as the "Tri-Area" of Jefferson County. While this investigation has been commonly referred to as a "storage analysis," it has not been limited to include only surface water storage options. Other water supply alternatives have also been explored, such as conservation, reuse, operational modifications to existing delivery systems, and aquifer storage and retrieval.

Although not a part of the project's initial scope, an additional task was defined by the WRIA 17 Planning Unit following a workshop. The nature of this task was to identify water supplies (both surface water and ground water) that might be used to supplement natural stream flows to potentially improve anadromous and native fisheries production and habitat conditions in the Big and Little Quilcene River watersheds. This effort, however, was not conducted with the benefit of analyses demonstrating water needs for fish, either in quantity of quality.

The scope of work included the following approach:

- ***Acquisition of Available Reports and Data.*** The effort began by obtaining available drawings, historic records, studies, and reports. The most current and detailed topographic mapping obtainable based on Geographical Information System (GIS) "LIDAR" imaging and US Geological Survey (USGS) maps were obtained through Jefferson County.
- ***Preliminary Review of Data and Development of a Preliminary List of Criteria and Alternatives.*** The evaluation considered a number of potential surface water storage options. These included entirely new water storage reservoirs encompassing natural storage features (i.e., local canyons and lakes), expansion of existing storage facilities (i.e., Lords Lake and City Lake), and the creation of entirely new storage facilities by excavating undeveloped property. The focus was kept to a corridor surrounding the primary water conveyance system for this region; namely the Olympic Gravity Water System (OGWS), simply because this provides the most viable and lowest cost transport of water.
- ***Workshop with Planning Unit Members to Refine Study Objectives.*** A workshop was conducted with interested members of the Planning Unit. Attending were representatives of the City, Jefferson County, and Jefferson County Public Utility District (PUD). This workshop served to narrow the project's focus to alternatives that were believed to best serve the intended purpose or goals for this study.
- ***Field Reconnaissance.*** Several field reconnaissance trips were made to identify, screen, and evaluate potential surface water storage sites.
- ***Alternatives Analysis.*** Analysis consisted of development of data on each of the targeted storage sites and on the potential alternatives of conservation, reuse, aquifer storage and retrieval, and operational modifications.

- ***Presentation and Report Development.*** Following a presentation to the Water Resource Inventory Area (WRIA) 17 Planning Unit, this report was developed to document the study and findings.

Section 4
Regional Setting

4.1 Water Supply

Water for eastern Jefferson County comes mainly from two sources: the Quilcene River system and ground water sources. The Quilcene River system, including the Big Quilcene and the Little Quilcene Rivers, supplies a maximum of approximately 19.4 million gallons (MG) per day (mgd) via a pipeline to the City of Port Townsend (City). The system has two raw water storage reservoirs along its path: Lords Lake (500 MG in size) and City Lake (120 MG). In addition to serving the residents of the City, this system also supplies the Port Townsend Paper Company (PTPC) with water for paper manufacturing. When interruptions to this surface water supply occur due to river turbidity or times of low flow, storage is used to compensate. The largest threat to the supply is extended periods of below normal rainfall and corresponding low river flows during the late summer and fall months.

The portion of the population not receiving water from the Olympic Gravity Water System (OGWS) (approximately two-thirds of the area's residents) obtains their supply from ground water. This supply can be from private domestic wells or from small to medium sized water systems. The largest of the ground water systems in the area is the Jefferson County Public Utility District (PUD) system in what is commonly referred to as the Tri-Area.

4.2 Water Use - Olympic Gravity Water System

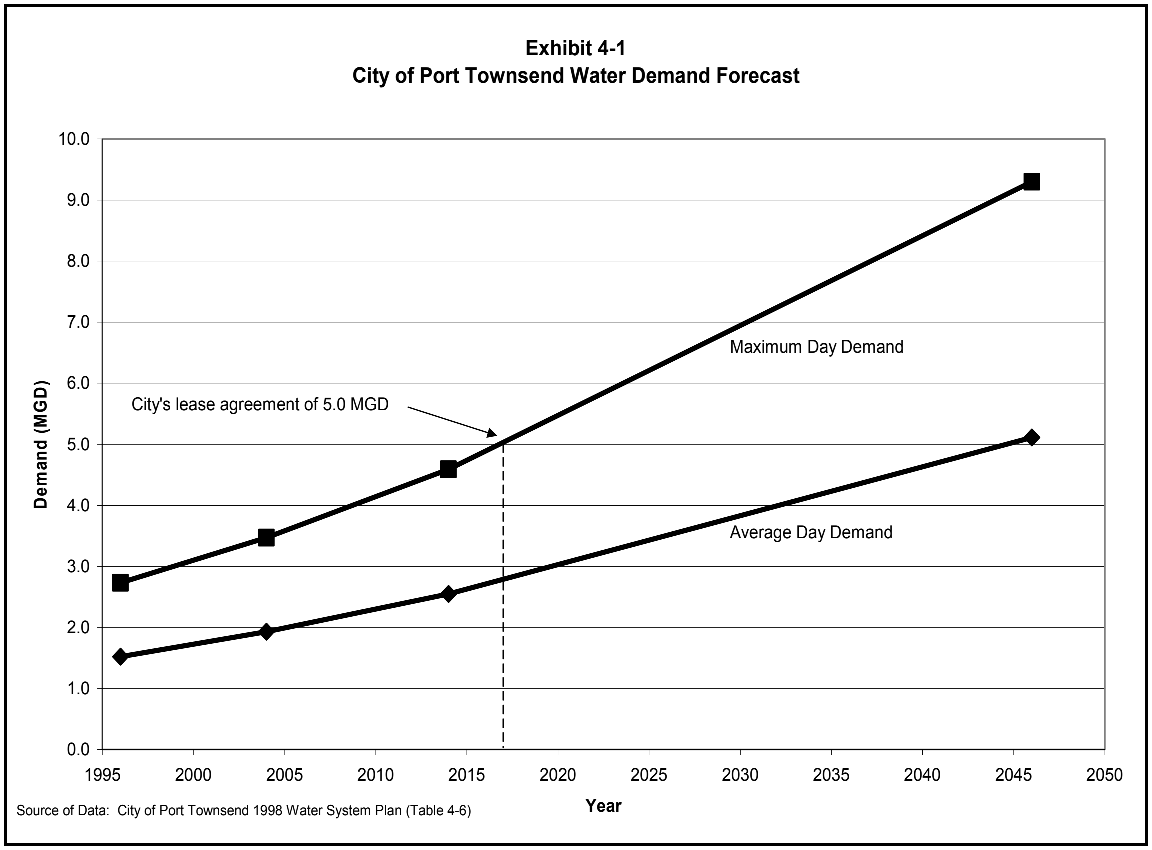
The City and PTPC are the primary users of the OGWS. The system was designed to meet the values generally represented in a contract between the City and PTPC. The contract allows the City 5 mgd and PTPC has the remainder of the system's capacity, which is generally described as a total of 19.4 mgd.

4.2.1 City Demand

The City currently has a population of approximately 8,455 (Washington State Office of Financial Management estimate, April 2002). Projections for future water use to year 2046 are presented in the City's Water System Plan. This information is provided in Exhibit 4-1. Actual population growth for the City has been less than that anticipated by the 1998 Water System Plan. Per capita water use has also been reduced since 1995. Current average day water demand (ADD) is approximately 1.0 mgd, and the peak day demand (PDD) is approximately 2.2 mgd.

4.2.2 PTPC Demand

PTPC, and the OGWS, operate at a set flow when water is plentiful. Power is generated with a 375 KW turbine driven by the water supply. The turbine is designed to operate given a constant water supply of 10,000 gallons per minute (gpm), or 14.4 mgd. Flows less than this significantly reduce the turbine's power factor and make it inefficient in generating power.



All water flowing through the turbine is used for power generation. While actual mill usage varies greatly depending upon which processes are operational at a given time, average water consumption is on the order of 12 mgd. This means an average of 2.4 mgd is used solely for power generation. During past low flow conditions, the turbine has been shut down temporarily, reducing total water usage at PTPC to paper production needs of approximately 12 mgd. With additional curtailment procedures in place (as discussed later), PTPC can operate at approximately 10.5 mgd. As recent events have shown, a reduction in pulp and paper production can bring the use down to 8.5 mgd (with job and profit losses). Additional techniques can be applied in the short-term (e.g., use of recycled materials for paper production, as cited in the Port Townsend Leader, October 30, 2002) to bring the use down further to 5.5 mgd.

4.3 Water Use – Tri-Area (PUD Service with Ground Water)

Prior to the transfer of the Tri-Area system from the City to the PUD, demands and forecasts for the area were provided in the City's Water System Plan (1998). The population of the Tri-Area in 1995 was approximately 3,120. The average demand from 1992 to 1995 on an ADD basis was 0.56 mgd. Included in this use figure are contracted amounts of approximately 114,000 gallons per day (gpd) to Indian Island (US Navy), and approximately 57,000 gpd to Marrowstone Island customers (Fort Flagler and a federal fish hatchery).

In the City's Water System Plan, projections for the Tri-Area include a doubling of the population to approximately 7,050 in 2046. This equates to a future demand of 1.32 mgd ADD and 2.84 mgd PDD.

4.4 Stream Flow and Storage Needs

The focus of this section is on the City's use of, and diversion from, the Big Quilcene River. The City's second supply from the Little Quilcene River is much smaller and has restrictions based on low flows in the river. This makes the Big Quilcene the critical supply, as diversions are made to supply the City and PTPC, as well as to fill reservoirs, prior to terminating diversions in order to implement the City's voluntary stream flow protection of 27 cubic feet per second (cfs). For all scenarios discussed below, it is assumed that water drafted from storage can only be used by the City and PTPC (i.e., via the OGWS). In other words, although flows are diverted from the river to storage, they cannot be rerouted out of storage back into the river to augment flows. This is the case with the current storage facility at Lords Lake and most of the proposed storage options discussed in Section 10.

The ability of storage, and other water supply alternatives, to meet regional needs aside from those of the City and PTPC is discussed later in the report.

4.4.1 "Typical Year"

In the City's Water System Plan (1998), a graphical presentation is made of the "typical" water flow in the Big Quilcene River. The "typical flow" compares closely to the 50 percent exceedance curve developed by Golder and Associates as shown in Figure 4.19 in the Quilcene-Snow Watershed Planning Instream Flow Assessment – Step A, June 5, 2003. The concept of this graphic has been modified, as provided in Exhibit 4-2, for use in this report to demonstrate:

- Stream Flow During a "Typical Year," – based upon actual stream flow data collected in the 1970s.
- Current Water Needs – City, PTPC (full operation), and instream flows (27 cfs). Currently the City has a voluntary commitment to leave 27 cfs (or more) in the Big Quilcene River.
- Future Water Needs – City (contract value), PTPC (full operation), and instream needs (27 cfs).
- Relative storage need under each of the above scenarios.

Exhibit 4-2 shows that the storage need in a typical year is easily satisfied by the system's existing storage (i.e., Lords Lake's 500 MG). It should be noted that City Lake is typically not included in system storage as it is used as equalization storage and does not provide significant long-term storage for the system. Even under the future water needs scenario, Lords Lake storage is sufficient under a "typical year scenario" well into the future (timing is dependent upon when the City's demands exceed 5.0 mgd).

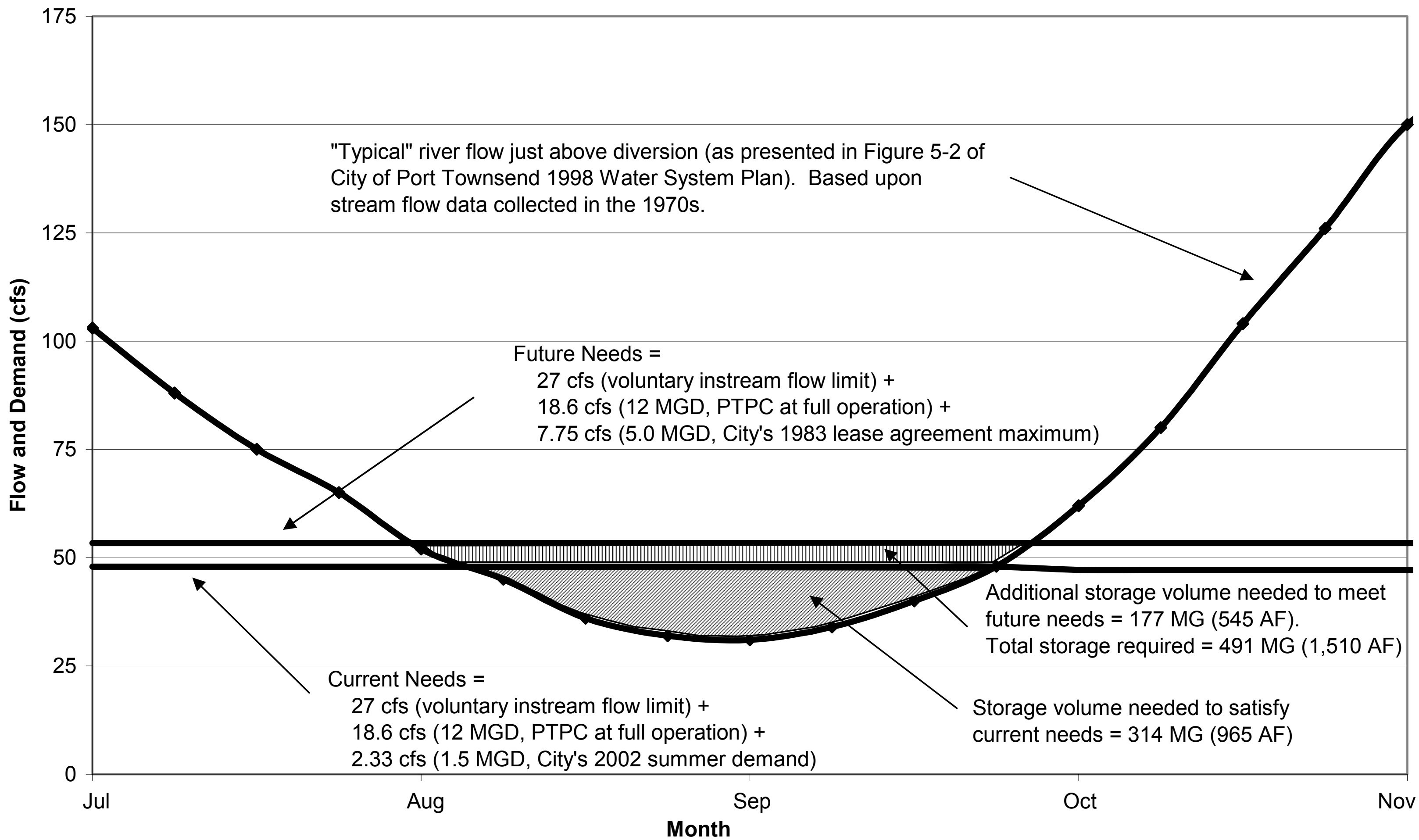
(Note: Subsequent to development of the analyses presented in this report, the City provided an alternative set of hydrologic data which could be used to characterize "typical" water flows near the Big Quilcene River diversion. Due to the limited timeline and budget associated with this report, these data were not incorporated in the analyses presented. However, the data should be considered in future efforts related to analysis of water supply and storage needs. Table 4-1 presents this alternative data set, as prepared by John Orsborn for the Environmental Assessment for the City of Port Townsend's Special Use Permit Renewal (2003). The information includes US Geological Survey stream flow data collected at the diversion since 1994.)

Table 4-1
Average Monthly Natural Flows (cfs) (modeled flows without diversion) for the Big Quilcene River below the Diversion and at Highway 101

	Big Quilcene River Below Diversion Average Annual Flow: 165 cfs			Big Quilcene River at Highway 101 Average Annual Flow: 200 cfs		
Month	**Maximum**	**Mean**	**Minimum**	**Maximum**	**Mean**	**Minimum**
Oct	267	94	24	332	117	29
Nov	416	180	38	521	222	44
Dec	581	245	77	700	296	94
Jan	588	251	53	689	296	63
Feb	492	224	54	583	266	64
Mar	375	178	66	443	210	79
Apr	310	177	94	365	210	112
May	370	204	101	452	250	126
Jun	334	175	78	417	220	98
Jul	228	101	41	284	128	51
Aug	115	56	25	144	70	31
Sep	128	46	21	159	57	26

Source: Orsborn, unpublished data, 3/12/2003.

Exhibit 4-2
Big Quilcene River Flows (Typical) and Water Needs
July-October



4.4.2 "Low Flow Year" (i.e., Drought in 2002)

Exhibit 4-2 was further modified to demonstrate the situation that occurred in 2002. Exhibit 4-3 depicts this flow scenario, which was one of the driest on record. For perspective, only two years show less precipitation – 1917 and 1987 (Bremerton Sun, November 1, 2002). The 2002 hydrograph depicts a drier period during November than the 90 percent exceedance curve developed for that month by Golder and Associates (June 5, 2003). This figure shows that 610 MG of storage were needed in 2002 to meet demands. This is 110 MG in excess of current storage capacity. The City and PTPC addressed this situation by enacting certain curtailments to reduce demands during the low flow time, as discussed later in the report. Considering future needs, the total amount of storage required for operation of the OGWS in drought years is approximately 875 MG, based upon graphical analysis of data presented in Exhibit 4-3.

The "Current Needs" and "Future Needs" lines do not remain horizontal during the entire time, because there is a period of time (late October/early November) during which river flows actually drop below 27 cfs. Since storage can only be used to meet City and PTPC needs (i.e., it is not available to augment stream flows), there is nothing that can be done to protect the 27 cfs stream flow once the river flows actually drop below that level. Storage could only aid in maintaining instream flows at 27 cfs if flow could be conveyed from storage back into the river.

4.4.3 "Stream Flow Management Options"

Subsequent to the above analysis and development of storage options to address the needs identified therein, the Planning Unit requested that additional scenarios be evaluated. These scenarios provide an estimate of storage needed under various types of stream flow management. These are hypothetical scenarios only. The discussion of storage options and costs presented in Section 10 is not based upon the storage needs identified in this section.

Another version of Exhibit 4-3 has been developed to show a hypothetical situation reflecting an increase in desired instream flows, and how storage may be used to manage such flows, at least in part. Specifically, Exhibit 4-4 shows future stream flow protection as being increased from 27 cfs to 30 cfs during the months of October through December. This has the effect of raising the "Future Needs" line on the graph by 3 cfs during a portion of that period of time. The resultant increase in required storage, over what was depicted in Exhibit 4-3, is 100 MG. This additional storage is required, as the City and PTPC would need to rely solely upon storage for a longer period of time in order to maintain the higher minimum flow of 30 cfs.

Another hypothetical situation is depicted in Exhibit 4-5, assuming that diversions from the Big Quilcene River are not permitted between September 1 and November 1 (the critical period for summer chum spawning). This is done to illustrate how storage needs may be calculated if river flows are not available for certain periods of time. As a result of leaving all flows in the river for the two month period of September and October, PTPC and the City must rely solely upon storage to meet their water needs. On a daily basis, therefore, storage must be able to provide 17 mgd, considering the "future needs" scenario (5 mgd for the City and 12 mgd for PTPC). The purely hypothetical situation characterized here indicates that there would be a total storage need of 1,290 MG. This storage requirement would be different for other lengths of “no diversion” periods.

Exhibit 4-3
Big Quilcene River Flows (2002) and Water Needs
August-December

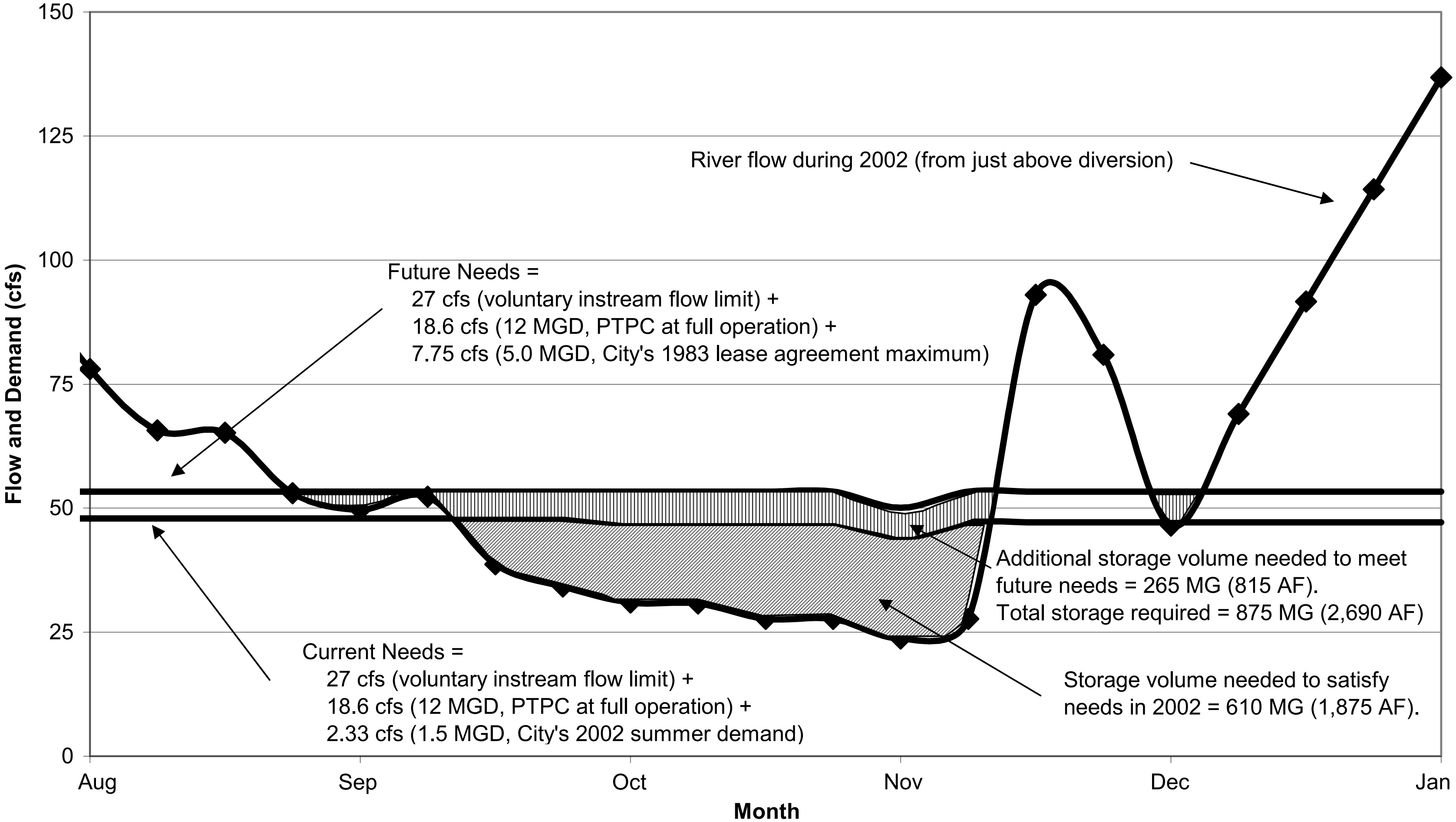


Exhibit 4-4
Big Quilcene River Flows (2002) and Water Needs
(with Instream Flow req't of 30 cfs from Oct 1 - Dec 31)
August-December

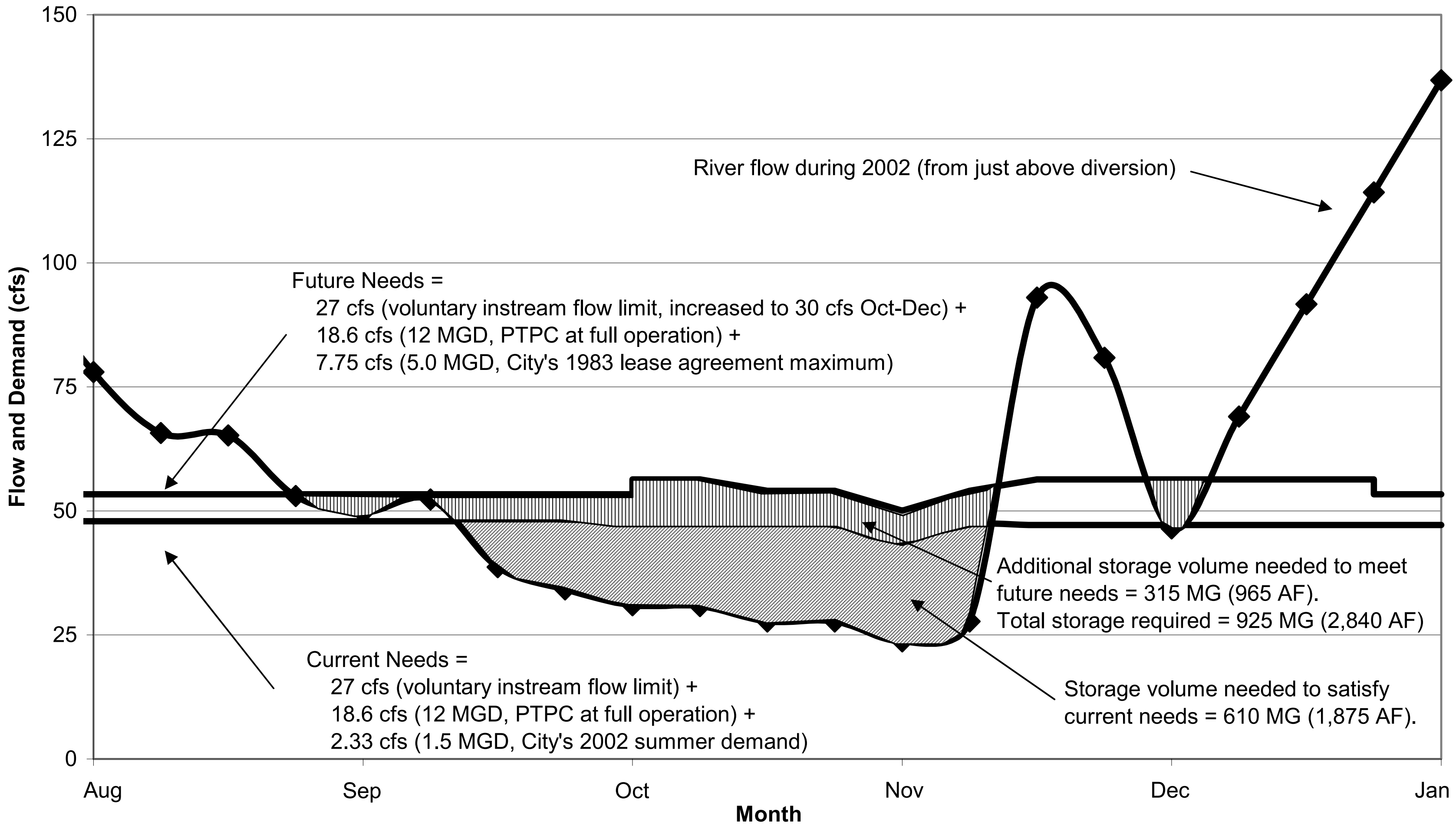
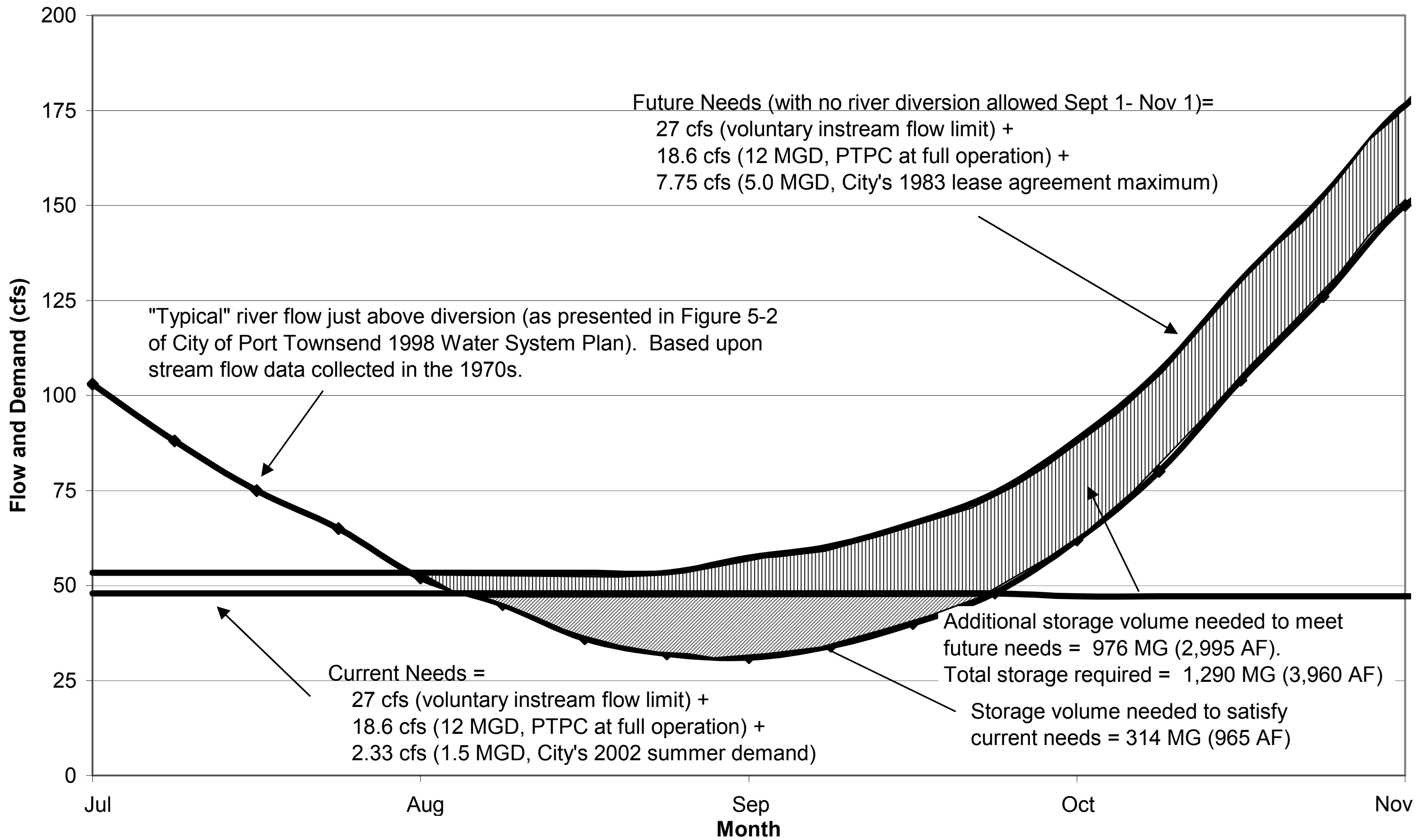


Exhibit 4-5
Big Quilcene River Flows (Typical) and Water Needs
(assuming no diversions for Sept 1- Nov 1)



4.4.4 Additional Notes Regarding Instream Flows

The WRIA 17 Planning Unit is continuing efforts to examine the topic of instream flows. Those efforts may establish a more precise instream flow need in terms of timing and quantity of water. With that information, a more refined storage scheme could be developed to aid in the maintenance and management of instream flows.

Section 5
Policy Setting

This section includes an examination of management options for the largest water systems in Jefferson County. In particular, the City of Port Townsend (City) and the Port Townsend Paper Company (PTPC) manage the largest system: the Olympic Gravity Water System (OGWS) capable of supplying up to 19.4 million gallons per day (mgd) from the Big Quilcene River. The Jefferson County Public Utility District (PUD) operates the second largest system which serves the Tri-Area (Chimacum, Hadlock, and Irondale) with ground water sources in the area.

The OGWS is owned by the City. Therefore, the City owns the water rights as well as the infrastructure. The City and PTPC operate under the terms of a contract which reserves 5 mgd for the City, with the remainder available to PTPC. PTPC operates the pipeline and reservoir system, and has total operational control. The current City-PTPC contract will expire in 2020.

The City's water supply policies, as summarized in Appendix G of the City's 1998 Water System Plan, stipulate that the City is obligated to reserve and/or develop the supply system capacity required to meet the current and future water demands within the City's incorporated limits and the City's urban growth area (UGA) boundary. Water supply not so required may be sold to non-City customers. Consequently, any suggested improvements or recommendations of this report are subject to review and consideration by the City, and subject to the terms of its existing contact. Similarly, the PUD has exclusive control over its resources, and management of its systems. The PUD will need to be consulted to implement any potential solution which affects their systems.

Finally, some proposed improvements are located on private property. All property owners have not been contacted, and any potential solution involving their property will require their consultation, involvement, and agreement.

Section 6
Conservation/Reuse

Water conservation and reuse are water supply alternatives that could be employed in Water Resource Inventory Area (WRIA) 17 to offset storage requirements by reducing potable water demands. The evaluation in this section is aimed at estimating the degree to which these options can offset, or reduce, the need for storage.

Information for the following analysis has been derived from the City of Port Townsend (City) and the Jefferson County Public Utility District (PUD) Water System Plans (developed in 1998 and 1996, respectively), and discussions with City, PUD, and the Port Townsend Paper Company (PTPC) management.

In the discussion below, it is important to note that the water volume comparisons (percentage comparisons) are done with respect to the storage volume needed in a "typical" year. If such calculations were performed considering a "low flow" year, the resulting percentages could be lower.

6.1 Jefferson County PUD

6.1.1 Conservation

The PUD has been providing conservation education for several years. In addition, the utility has implemented a conservation rate structure (increasing price with increasing use). In addition, the PUD implements leak detection efforts when unaccounted-for (metered vs. production) water reaches the 20 percent level in its systems. The PUD will likely lower this threshold in the near future as "acceptable" levels of unaccounted-for water are now in the range of 10-15 percent around the State.

There has not been an assessment of the effectiveness of conservation efforts within the PUD's systems. This is partly due to the fact that not all accounts have meters installed.

Reductions in demand might be significant within the PUD's systems and specifically in the Tri-Area system when compared with overall demand. However, these potential savings are small when compared with the overall storage needs for the region. For example, the 2014 demand estimated for the Tri-Area is 1.78 million gallons per day (mgd) (estimated by the City in their 1998 Water System Plan, prior to the system's transfer to the PUD). If a typical 1 percent per year reduction were achieved beginning in 2004, by 2014 the savings would be 0.18 mgd. If this is applied to the typical two month low flow period (i.e., August and September), the result is 11 million gallons (MG) or 2.2 percent of the required storage during "typical" flow years (491 MG, as shown on Exhibit 4-2).

6.1.2 Reuse

There are few significant opportunities for reuse currently in the PUD's system. However, Jefferson County is currently undertaking General Sewer Planning for portions of the area (including the business "core" of Hadlock). The results of this effort could include recommendations for construction of a sewage treatment plant, and the possibility of wastewater reuse (particularly on recreational areas). The extent of this possibility has not been analyzed. In addition, the approximate 44,000 gallons per day (gpd) flowing through the fish hatchery on the northern tip of Marrowstone Island may have reuse possibilities on the Island (Jefferson County Coordinated Water System Plan). However, such reuse activity would likely offset some future local water need that is not currently evaluated since public water is not provided elsewhere on the Island.

6.2 City of Port Townsend

6.2.1 Conservation

The City has been promoting conservation for several years. Their public education has involved school programs, informational brochure distribution, and an informational display at the Jefferson County Fair. The City's efforts have included specific programs such as those for service meters (now over 99 percent metered), an on-going leak detection program, distribution of conservation kits (toilet flow splitters, faucet aerators, etc.).

Currently, and in the future, the City will be focusing on unaccounted-for water. Analysis for their 1998 Water System Plan showed a 30 percent level of unaccounted-for water. More recent analysis indicates a 5 percent level of unaccounted-for water. Efforts will be focused on reductions where appropriate.

Landscape management (xeriscape) is also a thrust for specific customers. For these targets, it is hoped that a 10 percent reduction in use can be achieved.

Overall, the City has targeted a 5 percent reduction in use by 2004 (over 1998 levels). The City has indicated that future water savings associated with conservation efforts would be approximately 3-5 MG over the two month low flow period (compared with the 491 MG needed in a "typical" flow year).

On a broad perspective, many communities are targeting a 1 percent per year savings. The City's 2004 targets are in line with this level, but no savings are planned beyond the 2004 level. This reflects the debate over the extent to which conservation can continue to have effects, and the fact that overall water use will increase as the City's population continues to grow. Some planners believe that conservation savings are limited, and the effect of conservation programs will peak in the near future, consistent with the approach taken in the City's projections.

6.2.2 Reuse

Major sources of supply for reuse within the City are limited. A focus of past analysis has been the City's sewage treatment plant. The only potential significant user of this supply is the City's golf course. During peak months, the facility demands about 100,000 gpd, based on Water System Plan data. However, more recent information indicates usage in closer to 65,000 gpd. Over the two month low flow period, this amounts to approximately 4 MG or 1.0 percent of the storage requirement over the two month low flow period of a "typical" year.

6.3 Port Townsend Paper Company

6.3.1 Mill Operations

A key curtailment option available to the Olympic Gravity Water System (OGWS) is the shutting down of PTPC's power-generating turbine. This option has been utilized in the past during low flow periods. With regard to this curtailment option, an important fact pertaining to the impacts that the mill can have upon water demands is the following: water conservation enacted *within* the mill reduces water consumption *only* when PTPC's turbine is turned off. This is because a constant flow of water (14.4 mgd) is sent through the turbine (see Section 4.2 for details); therefore, if PTPC reduces water usage within mill operations by a certain amount, the resultant effect is an increase of the same amount in the overflow, or spilled water. The flow through the turbine is still maintained at 14.4 mgd. With this in mind, a recommended operational strategy for PTPC is to shut the turbine off immediately when drafting of system storage (i.e., Lords Lake) begins in order to meet needs during low flow periods. In this way, stored water will be used most efficiently. This, in concert with conservation and curtailment measures discussed below, will aid in optimizing use of the existing and future storage facilities.

There is a cost to PTPC (in the form of a lost power credit) of approximately $200 per day when the turbine is shut down. Because the shut down reduces water flow to the mill by approximately 2.5 mgd, the cost of this measure is $80 per MG of water saved.

6.3.2 Curtailment

The most recent supply shortage (2002) provided confirmation of the following procedures for temporary curtailment enacted by PTPC:

- Prior to curtailment: Flow at 14.4 mgd
- Turbine shut down: Flow lowered to 12 mgd
- Curbing of excessive use of water for general cleaning and maintenance purposes: Flow lowered to 10.5 mgd
- Stop production on one paper machine for two weeks: Flow lowered to 8.5 mgd

As was demonstrated in 2002, the curtailment process culminated with a shut down of paper production and loss of jobs in the last two weeks of a low flow period that was about two months long, similar to the "typical" low flow period, but starting about a month late. However, this low flow period resulted in an overall larger deficit because of lower flows for a greater proportion of the two month period.

6.3.3 Conservation/Reuse

The mill has been actively pursuing conservation and reuse for several years. The City's 1998 Water System Plan provides the following summary of historic and possible future actions:

Table 6-1
PTPC Mill Conservation Activities

Usage Reductions and Options for Additional Reductions	Year(s) of Change	Increase or Decrease in Flows (mgd)	Mill Water Use (mgd) (1)
1995 Usage			
Normal diversions with mill overflows	1995	--	13.50
Normal diversions w/o mill overflows	1995	-1.50	12.00
Recent and Impending Changes			
Recycle Plant operation	1996	0.72	12.72
Potential Water Use Increases			
Recycle plant Phase II	Not sched.	0.35	13.07
Other Conservation Opportunities			
1) Reclaim vacuum pump seal water	Not sched.	-0.72	12.35
2) No. 10 PB system on recycled water	Not sched.	-0.35	12.00
3) Cooling water reclaims	Not sched.	-0.50	11.50
4) Reduced feedwater make-up	Not sched.	-0.15	11.35
5) Chemical pulp mill shut down	Not sched.	-2.00	9.35

Source of data: Table 5-3 from City of Port Townsend Water System Plan (1998)

(1) The resulting usages based on the changes presented in this table are computed from 12 mgd (normal diversions without mill overflows).

As can been seen from the table above, there are conservation measures yet to be scheduled or completed. The most significant of these is the shut down of chemical pulp production. This would be a permanent scenario that would require PTPC to shift its raw materials and market base, resulting in capital expenditures of at least $100 million needed to retool the mill, as estimated by PTPC staff. Aside from this drastic and highly unlikely measure, an additional savings of 1.72 mgd is possible, but currently no plans are in place to implement these improvements. Total costs for the other conservation activities is estimated to be on the order of $400,000, according to PTPC staff.

If all conservation were in place (except closure of the chemical pulping facility), "typical use" would drop by 1.72 mgd, a reduction which over a two month low flow period could amount to 103 MG or 21 percent of the storage need for a "typical" period.

Section 7
Conjunctive Use

Conjunctive use is a well known concept in water management and has been used in many areas of the country to optimize both surface and ground water supplies. Under this concept, during high flow periods, surface water would be provided to areas currently utilizing ground water (e.g., the Tri-Area), thereby "resting" the ground water aquifers. During low flow periods, these ground water sources would be used to augment or replace reduced surface water supplies to the City of Port Townsend (City) and the Port Townsend Paper Company (PTPC). This concept can be expanded to use of any ground water source (existing or new) to supplement supply during low flow periods.

The discussion below focuses primarily upon use of the Jefferson County Public Utility District's (PUD) wells in a conjunctive use scenario. If this approach is pursued, further work might be done to examine not only the PUD's existing ground water supplies, but also the Kala Point Supply (because of its proximity to the Olympic Gravity Water System (OGWS)). This logic then expands to finding any new ground water source along the OGWS pipeline to augment supply.

Table 7-1 contains basic data pertaining to the PUD system, including water rights, well capacities, and water demands.

Table 7-1
Jefferson County PUD Water Sources and Demands

Water Rights		
Annual (Qa)	1.14 mgd	
Instantaneous (Qi)	3.53 mgd	
Well Capacities		
Sparling #1	0.90 mgd	
Sparling #2	1.73 mgd	
Kivley	0.14 mgd	
Total	2.77 mgd	
Treatment Capacity	1.50 mgd	
Water Demands		
Year	Average Day (mgd)	Peak Day (mgd)
2004	0.72	1.56
2014	0.83	1.78
2046	1.32	2.84

7.1 Discussion

Total pumping capacity for the PUD's system is 2.77 million gallons per day (mgd). If this supply were treated (currently there is not enough treatment capacity), and provided to the OGWS to augment City and mill needs, the Tri-Area needs would need to be deducted first. In 2004 (at 1.56 mgd peak day demand (PDD)) this would leave approximately 1.21 mgd of "surplus" water that could be sent to the City and PTPC. During the two month low flow period in a typical year, this would be 72.6 million gallons (MG) (15 percent of the storage required in a "typical" year). This is a significant amount of water considering the production curtailment for PTPC in 2002 was approximately two weeks at about 3.5 mgd or 50 MG. As noted above, the Tri-Area use will expand, so this "surplus" will diminish over time unless new source(s) are found.

Obviously this Tri-Area conjunctive use concept has both promise and problems:

- It is promising in that a good source or sources of ground water could supply both the City and PTPC with a need during low flow periods. Depending on the amount of "surplus" ground water, this conjunctive use could allow for more surface water to remain in the rivers to maintain instream flows during low flow times of the year.
- This concept has problems in that ground water is not known to be plentiful or of high quality. Any use of the existing Tri-Area sources would require treatment for iron and manganese. Based upon a unit capital cost of $850,000 per mgd, the capital cost of such facilities to treat the remaining 1.77 mgd of well capacity that exceeds the existing 1.50 mgd treatment capacity is $1,500,000. Annual operating and maintenance (O&M) costs are estimated to be $40,000, including labor, chemical, maintenance, and power costs. Assuming a service life of 20 years for the treatment facilities, the total O&M costs for 20 years (in 2003 dollars) is $800,000.

  Therefore, to *provide* 72.6 MG *to* the OGWS during a two-month low flow period, the total cost per MG is approximately $32,000.

  Furthermore, during plentiful surface water periods, if the Tri-Area were provided surface water from the OGWS, this water would also have to be treated to meet drinking water standards (generally interpreted to mean a filtered supply). Based upon a unit capital cost of $1,500,000 per mgd, the capital cost of such facilities to treat the 2004 PDD of 1.56 mgd is $2,340,000. Annual O&M costs are estimated to be $60,000, including labor and maintenance costs. Assuming a service life of 20 years for the treatment facilities, the total O&M costs for 20 years (in 2003 dollars) is $1,200,000.

  Therefore, to *receive* 72.6 MG of supply *from* the OGWS (an amount equal to that provided to the OGWS from Tri-Area sources during low flow periods), the total cost per MG is approximately $50,000.

  Adding the costs of both ground water and surface water treatment, the total cost per MG is approximately $82,000.
- This concept also has promise if it were expanded to include a network of ground water sources along the OGWS pipeline route. While these sources would require additional water rights, the environmental impact might be tolerable depending on the basin in which they are located. Treatment may or may not be needed depending on the quality of water. The US Geological Survey (USGS) is completing a study in ground water characterization of eastern Jefferson County, which may help to better define such options in the future.

Based upon a unit capital cost of $200,000 per mgd (i.e., the cost of two 100-foot deep, 350 gallon per minute (gpm) wells), the cost of new wells to provide 1.2 mgd to the OGWS (which represents 72.6 mgd over a two month low flow period) is approximately $240,000. Annual O&M costs are estimated to be $5,000, including power and maintenance costs. Assuming a service life of 20 years for the wells, the total O&M costs for 20 years (in 2003 dollars) is $100,000.

Therefore, to *provide* 72.6 MG *to* the OGWS during a two month low flow period, the total cost per MG is approximately $5,000. This assumes no treatment of this ground water is necessary. If such treatment were necessary, costs would be similar to those described above for the expanded use of the PUD wells.

Combining this with the cost of surface water treatment (for water received from the OGWS), the total cost per MG is approximately $55,000.

Section 8
Aquifer Storage and Retrieval

Aquifer storage and retrieval (ASR) is a concept that is being implemented in some areas of Washington State. Under this approach, aquifers are recharged by surface water (by injection wells or infiltration) during a high flow period, then used during dry months that are accompanied by diminished surface supplies. When used in conjunction with surface supplies, it becomes an extension of the conjunctive use concept described above.

For this approach to work, soils and geology have to be such that water placed in storage is available (i.e., has not dissipated) when needed.

For this study, several sources of information were reviewed including:

- Well logs for various areas in eastern Jefferson County
- A hydrogeologic assessment of eastern Jefferson County currently being completed by the US Geological Survey (USGS)
- *Eastern Jefferson County Groundwater Characterization Study* (Jefferson County PUD, May 1994)
- *Sparling Wellhead Analysis* (City of Port Townsend 1995)

These studies indicate that the soils and geology in the area would make the concept difficult to implement because the aquifers are limited, and not confined.

During the workshop, members of the Planning Unit expressed their concerns that along with these indicators, it was generally understood that implementation of ASR would require extensive study and be extremely costly.

The USGS is under contract to produce a detailed report of ground water in eastern Jefferson County. Contact was made with the USGS, and based on the extensive work completed to date, it appears the area would not offer much potential for ASR (Personal Communication, Bill Simonds, USGS, April 2003). The area contains multiple discontinuous aquifers, without any real boundaries, so water put into the ground would likely disperse, and migrate to salt water. Retrieval of the stored water would therefore be difficult.

Based on these data, concerns, and reports, this option was not pursued further.

Section 9
Olympic Gravity Water System

The Olympic Gravity Water System (OGWS) was constructed in the late 1920s to accommodate the needs of the Port Townsend Paper Company (PTPC) and the City of Port Townsend (City). While the system has been upgraded in many ways, and additional supply from the Little Quilcene River added in 1956, this 28.5 mile pipeline and system operates in much the same way today as it did in the past.

9.1 Operation of the OGWS

The OGWS transfers water from the Big Quilcene and Little Quilcene Rivers through Lords Lake and City Lake and into the City. Water is stored in two City-owned elevated reservoirs (total storage 6 million gallons (MG)) and one 100,000 gallon reservoir owned by PTPC.

Water from the Big Quilcene River enters the OGWS through a diversion intake and flows by gravity to City Lake. The Little Quilcene diversion flows to Lords Lake, also by gravity. Water from the Big Quilcene River can be diverted from the transmission line into Lords Lake. If Lords Lake overflows, a spillway returns water to the Little Quilcene River via Howe Creek.

A combined flow from the Big Quilcene River and Lords Lake can flow to City Lake. While it is possible to bypass City Lake, all water from the Big Quilcene River and Lords Lake passes through the City Lake reservoir. When City Lake reaches capacity, water flow from the Big Quilcene River and/or Lords Lake is reduced.

After leaving City Lake, the water is screened and chlorinated. Because of water quality regulations (chlorine contact time (CT)) water that enters the City system flows to the two reservoirs prior to being supplied to any customers. Water flowing to PTPC does not go through the City's reservoirs but meets minimum CT requirements, according to the City.

9.2 Operational Improvements

It is not possible to efficiently fill both Lords Lake and City Lake at the same time. When the valve is closed downstream to force backpressure on the line and direct water to Lords Lake, there is cavitation in the pipeline downstream of the valve.

Installation of flow control valves at the appropriate locations in the pipeline can provide the operators with the ability to fill both reservoirs at the same time and to run the system at a level of higher efficiency.

The valves need to be located carefully to take advantage of the relative elevations of the diversions and lakes. In addition, the line could become over pressurized if flows in the line are diminished to too great an extent. Selection of locations for the control valves must take into consideration potential static pressures in the line. An elevation of 600 is likely to be the lowest elevation that could be used for any control valves.

The existing valves are operated manually. Staff are currently required to go to the site to open or close the valves. Any new control valves should be capable of automatic adjustment and should be remotely controlled (able to be opened or closed from a central location).

9.3 Costs/Benefits

Costs for the modifications to the control valves and installation of valve telemetry are small compared to the capital costs for new storage. The new valve is estimated to cost $25,000 including telemetry, power operation, and the other required fittings to install it into the existing pipeline.

Benefits from installation of the valves and telemetry are primarily realized by the operations personnel who manage the pipeline. They will have to travel less to operate the system, will have better information on the operation of the pipeline, and the reservoir levels will be easier to maintain.

However, having the new valves and telemetry will *not* assist in providing additional water during periods of low flow in the rivers. The primary benefit is accrued during the higher flow periods with less flow in the pipe and more remaining in the rivers (i.e., available for maintaining higher instream flows).

Section 10
Storage

This section describes the selection and evaluation of potential surface water storage sites that would be used to meet the objectives of this study.

10.1 Initial Site Selection Criteria

Among the criteria used to determine whether a storage site location or feature was worthy of review were the following:

- Relative close proximity to the Olympic Gravity Water System (OGWS) pipeline and/or other population centers.
- Multiple benefits extending to other water users beyond the Port Townsend Paper Company (PTPC) and the City of Port Townsend (City).
- Net positive impacts on native and anadramous fisheries and other wildlife.
- No obvious "fatal flaws" from an environmental impact or permitting perspective.
- An impression of there being a positive cost/benefit relationship.
- Overall sense that the project or site had a fairly strong likelihood of completion success factoring in public benefits, facility cost, satisfaction of water storage goal, local and tribal support (or at least not strong opposition to), etc.

10.2 Preliminary Site Selection

A preliminary list of sites were selected and presented to the workshop of Planning Unit members (City, Jefferson County, and the Jefferson County Public Utility District (PUD)). This list included the following:

- Expansion of Lords Lake and City Lake
- Pederson Lake
- Gibbs Lake
- Delanty Lake
- Anderson Lake
- Use of the Morgan Hill reservoirs

During the workshop the following direction was provided by those attending:

- Do not evaluate the Morgan Hill reservoirs – The City has already established that they are at the wrong location to be useful, and because of leaks, they are unstable and dangerous.
- The use of Anderson Lake or Gibbs Lake will be difficult due to their current recreational use.
- Other lakes may be possibilities – e.g., Tarboo Lake.

- The City has its needs "guaranteed" under its contract. Many storage options to deal with situations similar to 2002 may only benefit PTPC. Instream enhancements (for fish) should be an equally important selection criteria.

10.3 Refined Site Selection and Analysis

Following the input received from the workshop, a select group of potential storage sites was developed, using the following approach.

10.3.1 Hydrology

First, available hydrologic records were collected and used in evaluating the hydrologic potential of each site. Then, the suitability and reliability of the source was assessed to determine if the source was a satisfactory option for delivering water to a proposed storage feature. During preliminary review of the 2002 low flow event, a range of storage goals was identified, with the lowest end of the range defined as 80 million gallons (MG) or 246 acre-feet (ac-ft), knowing that at least 50 MG of additional storage (equal to the approximately two weeks of temporary mill shut down that occurred) was needed in 2002 to forego temporary shut downs of mill processes. All of the prospective projects considered herein would satisfy that goal.

While the options were not sized to meet the storage needs identified under the "stream flow management options" discussion in Section 4.4.3, the unit costs developed for the options could be applied to those identified storage needs in order to obtain an estimate of cost for such facilities.

10.3.2 Conceptual Design

The approach involved securing available mapping and topography and other background information for each site from the Jefferson County Geographical Information System (GIS), US Geological Survey (USGS), etc. Each potential storage site was visited. Land acquisition requirements, parcel owners, and the Jefferson County Assessor records were acquired to establish land values. Project elements including access roads, inlets, outlets, etc. were sized and determined. Finally, conceptual level plan layouts and sufficient cross sections and details were completed to enable cut and fill calculations to be performed along with projected water storage volumes.

10.3.3 Cost Estimates

This task involved completion of an estimate of probable costs to construct each storage project including costs of land acquisition, access roads, project features, engineering and construction management, and recommended contingencies.

10.4 Site Analysis

This section describes in greater detail the six specific storage options evaluated. Exhibit 10-1 provides locations of each site, while Exhibits 10-2 through 10-7 provide site maps and typical cross sections for each alternative. These exhibits are provided at the end of this section.

10.4.1 Penny Creek Drainage Water Offset Project

Penny Creek is one of the few remaining "undeveloped" or underutilized surface water sources existing in close proximity to the OGWS. Runoff from this high elevation watershed could be captured in a common, arch-section embankment. Given that the OGWS pipeline is located at a higher elevation than Penny Creek, introducing or diverting this water into the OGWS would likely be costly and technically challenging. However, the potential value of offsetting or replacing Quilcene flows during low flow periods for the benefit of fisheries is attractive and worth pursuing with regard to this option. The storage yield from this reservoir could translate into 4 cubic feet per second (cfs), supplementing naturally occurring flows during a given low water month (e.g., August or September). This would result in a range of potential management options. If 4 cfs were introduced into the Big Quilcene (at the fish hatchery) *and* City/PTPC diversions were also increased by 4 cfs at the same time, there would be no net effect on flows downstream of the hatchery, but flow would be reduced between the diversion and the hatchery. If, however, City/PTPC diversions were not increased when the 4 cfs were introduced into the river (due, for example, to the existence of other storage facilities to meet needs), the resultant effect would be a 4 cfs increase in flows downstream of the hatchery.

10.4.2 Lords Lake Expansion

Lords Lake serves as Jefferson County's primary water storage reservoir. The possible expansion of Lords Lake was previously studied by Camp Dresser and McKee (CDM), in October of 2000. Two expansion alternatives were examined at that time: a 100 percent capacity increase and a 50 percent capacity increase. CDM concluded that both expansion alternatives were not feasible due to difficulties with filling the enlarged reservoir. However, a smaller expansion may be feasible. Based upon Lords Lake's present capacity of 1,660 ac-ft, a 16 percent expansion would meet the target storage expansion goal of 80 MG. Costs for this alternative were based upon CDM's unit costs for the 50 percent capacity increase, with a few items added in order to be consistent with the estimates prepared for the other options. This is a strong alternative, particularly in view of its comparatively low unit cost for storage, and relative ease in permitting an expansion of an already existing facility.

10.4.3 City Lake Expansion

Expansion of City Lake, the City's existing daily regulating or balancing reservoir, was another of the options considered to create additional storage capacity. City Lake has a present capacity of 370 ac-ft and is used to satisfy very short-term (hourly) variations between demand and supply. Advantages of a potential expansion to this reservoir include a lower unit cost for storage given the existing facilities already in place (reservoir, pipelines, screening facility, etc.), its close proximity to the water demand center, and comparatively simple permitting requirements. The intention for this alternative is simply to expand and raise the existing embankments by 10 feet. In this case, 10 feet of additional water storage depth translates into an additional 300 ac-ft of volume, nearly doubling the present capacity of this facility.

10.4.4 Excavated Site Storage

One of the more interesting alternatives considered is the concept of excavating an impoundment out of an undeveloped land tract near the OGWS. From a planning and engineering perspective, there still remains a number of workable, undeveloped land parcels; and, property for this type of facility would likely be more easily obtained than for some of the other options considered. The supply source for an "excavated" reservoir could be either a diversion directly off the OGWS pipeline, or perhaps a new ground water well.

The concept for this type of facility relies on the direct excavation and reuse of native soils and a balanced cut/fill earthmoving operation. It is assumed that there are sufficient, low cost sources of low permeability soils to allow this type of project to work from an engineering perspective, and if believed necessary, an impermeable membrane liner could be utilized to insure water-holding integrity. The layout of this project was intentionally conceptualized to result in a storage yield matching the target goal of 80 MG. Depending upon the positioning of an "excavated" reservoir facility, the size and resulting storage capacity could be much larger than the 80 MG target. A larger reservoir facility would obviously provide additional water for extended drought periods to address either domestic/industrial or fisheries-related water needs.

10.4.5 Natural Lake Storage

The region surrounding the OGWS pipeline has numerous natural lakes of various sizes and characters that could be considered attractive for their storage potential. Among these are Delanty, Tarboo, Petersen, Anderson, and Gibbs Lakes. Each one of these lakes has unique characteristics, and in turn advantages and disadvantages. Given the budget limitations for this review, this alternative was simplified by creating a "generic" natural lake alternative. A cost estimate was then prepared for that generalized version. The concept requires the diversion of surplus flows from the OGWS pipeline during high flow/low demand months and any contributing drainages, and reintroduction of the stored water at high demand/low flow periods. A diversion and return pipeline, or conveyance and a pumping plant would be necessary given the relative elevation differential between the OGWS pipeline and all of the natural lakes examined. Permitting for this type of project would be difficult and relatively costly, as would the anticipated mitigation requirement (currently a 3 for 1 exchange, meaning for every acre of natural wetland removed or degraded, 3 acres of offsetting constructed wetlands are required). Nevertheless, taking advantage of one or more of the many existing natural storage features seems to be a logical and viable method of extending the area's water resources.

10.4.6 Other Potential Options Considered

In addition to the alternatives identified above, several other options for surface water storage were briefly considered. On-channel, run-of-river impoundments on either the Big or Little Quilcene River upstream of the existing diversion structures are potentially viable options. Significant permitting difficulty, as well as substantial expense and time to obtain a new instream diversion/withholding right, is anticipated with this alternative. Nevertheless, the terrain in each of these areas is conducive to a water storage reservoir, each drainage has fairly good road access, and other favorable characteristics to merit further consideration. Either drainage could readily provide the desired storage target. Further research and review of the potential permitting and environmental issues is warranted. From a cost perspective, an on-channel storage facility sized at 250 ac-ft is expected to have a total cost on the order of $5 million.

Other run-of-river, both off- and on-channel, storage options exist within Jefferson County that could provide storage to meet regional needs, such as Tri-Area demands, and would not necessarily be targeted for connection to the OGWS (i.e., Chimacum and Thorndyke Creeks). However, the cost and difficulty associated with attempting to secure Department of Ecology approvals and new surface water diversion water rights make such options less attractive than the others discussed above.

The old Morgan Hill reservoir site within the City warranted a brief look, but was quickly ruled out due to size limitations (5 MG) and security and safety concerns. A new steel or concrete tank storage facility at the original Morgan Hill site is not likely to be approved and constructed given today's current economic conditions, tight capital improvement budgets, safety and insurance-related concerns, and what would be a relatively high unit cost for storage, given a small site.

10.5 Cost Estimates

To extend the evaluation of the candidate storage sites, reasonably detailed cost estimates were developed for each alternative, based upon preliminary layouts, cross sections, and details. The cost estimates include costs of construction materials, equipment, and other elements related to such projects. "Hard" and "soft" cost items were captured to the extent possible, so that a realistic understanding of project costs is obtained for future evaluation and planning. More detailed engineering designs would result in better precision in these cost estimates, but given the limitations of this grant budget, a 30 percent contingency has been included to account for any inaccuracies in take-offs or unit pricing, as well as unforeseen items that will undoubtedly occur during the course of construction. The contingency includes the need for permitting, which may in turn involve such activities as mitigation (e.g., wetland construction, fish ladder construction, etc.).

The estimates reflect current Washington State Dam Safety standards and design requirements. Items such as perimeter fencing, emergency spillways, reliably controlled outlet works, etc. are reflected in these requirements and in turn, in the project cost estimates.

The Jefferson County Assessor's Office was contacted for assistance in estimating land values, which were then confirmed via phone conversations with several randomly-selected local realtors.

Individual property owners were not contacted to inquire what value or pricing they would want for their property, in order to avoid alarming residents and perhaps obtaining unrealistic land values.

A major exclusion to the cost estimates should be noted. It is not known how sponsoring agencies, water user groups, and other beneficiaries might fund these potential projects and, as such, no attempt was made to estimate costs of project financing and debt repayment. With this cost element factored into, or added to the estimates, a generally complete planning level estimate of costs for each alternative could be finalized.

Table 10-1 provides a summary of the planning-level cost estimates. It is interesting to note that the costs for the alternatives reviewed range from $0.96 million to slightly over $2.4 million, with the exception of the run-of-river option which is estimated at $5 million (again excluding project financing costs). The unit cost for storage for the expansion of Lords Lake (50 percent) and City Lake, the two alternatives considered to be most attractive in terms of economic benefit are $3,900/ac-ft and $4,100/ac-ft respectively. The unit cost for the Penny Creek alternative, which includes potential benefits to fisheries, is not much higher at $4,503/ac-ft.

Table 10-1
Summary of Storage Option Cost Estimates

Storage Project	Total Storage Provided		Estimated Capital Cost	Unit Cost of Total Storage	
	Acre-Feet (AF)	Million Gallons (MG)		Per Acre-Feet (AF)	Per Million Gallons (MG)
Penny Creek	258	84	$1.16M	$4,500	$14,000
Lords Lake Enlargement	246	80	$0.96M	$3,900	$12,000
City Lake Enlargement	298	97	$1.21M	$4,100	$12,500
Off-Channel Excavated Lake	249	81	$1.56M	$6,300	$19,000
Natural Lakes	279	91	$1.30M	$4,700	$14,500
Run-of-River, On-channel	250	81	$5.00M	$20,000	$62,000

10.6 Management Options

The operation and management of any the proposed storage facilities could have a large impact on how effective a new off-channel storage facility is at addressing Jefferson County's drought reserves and increasing water demands. Storage alternatives have been selected and evaluated that benefit the largest number of people and as many diverse interests as possible; a goal that is always a challenge on public works projects of this type and scale.

The following comments are offered in relation to how these facilities might likely be operated and best utilized:

- The Penny Creek alternative (and the Big Quilcene on-channel storage option as well) offers the greatest direct benefit to depressed and threatened local fisheries as stored water could be routed directly back to the Big Quilcene to augment flows. These facilities would be located well upstream of anadromous barriers, and flow releases could be timed to provide the maximum benefit to fish and wildlife habitat. Generally speaking, these options would be used to store surplus spring runoff and peak storm event flows that exceed the instream flow and current diversion requirements. Stored water would then be released during the late season low flow periods.

It is also conceivable that water from one of these "upstream" alternatives could be used by the PUD, as well as by the City and PTPC, if certain water delivery tie-ins and OGWS improvements were made.

Detailed planning of on-channel storage options should consider the sediment load in the river, and the impact of this upon reservoir sizing.

- An expanded Lords Lake would allow increased flexibility in how and when water is conveyed to downstream users, and conceivably could provide an expanded water supply for longer drought periods than other options considered. This alternative has the lowest unit cost for storage of any of the options examined. Given that this is an existing water delivery system, this alternative rises to the top in the evaluation of options.
- The excavated storage facility option could be sited in a number of locations within close proximity to the OGWS. In addition, this approach could be used in the Tri-Area provided an acceptable and economic supply source is identified. Diverting and transferring water from the OGWS pipeline is certainly an option, as is a ground water well source, but the implications and costs of any new supply and delivery or return facilities have to be considered in a complete evaluation of this option.
- Any of the natural lake sites examined is problematic from the standpoint of permitting, source water supply, and delivery. With that said, a good number of the local lakes unquestionably have untapped water storage potential. Of the regional lakes examined, Tarboo Lake appears to show the most promise or potential.
- An expanded City Lake would be beneficial to the City and PTPC, and could possibly benefit other downstream water users or interest groups.

******WP: Include 7 CAD exhibits at end of this section. They are 11x17 landscape PDFs, numbered Exhibit 10-1 thru 10-7.******

WRIA 17 – Storage Analysis Report
Responses to comments on revised final report dated October 14, 2003
(Note: Comments are in italicized font. Responses are in bold.)

I. City of Port Townsend comments

Table 1-1
If there was more water left instream because of construction or expansion of a reservoir, conservation, or conjunctive use there would be a benefit to fish. The benefit to people and fish columns should be deleted.

These two columns have been deleted, per comment.

Note 1 talks about the low flow period being Aug to Sep whereas section 4.4.3 discusses the need for water instream between Sep 1 and Nov 1. The later period being most critical for summer chum it would be appropriate to change note 1 to Sep-Oct.

Text was revised to read "late summer/early autumn", as the actual timing of the "low flow" period varies between years (e.g., Aug-Sep for a "typical" year vs. Sep-Oct for 2002).

The additional surface water storage (water provided or saved during low flow period) should include a range of storage size for the other "stream flow management options" (4.4.3) including, maintenance of 30 cfs instream flows (an additional 100 MG above that in figure 4-3) and no diversions between September 1 and November 1 (a total storage need of 1290 MG), as well as a range of cost for the various sizes of storage.

The discussion of various "flow versus need" scenarios (in Section 4) is separate from, and was not used as a basis for, the discussion of specific storage options (in Section 10, and summarized in Table 1-1). During the Planning Unit workshop, it was decided that detailed storage options (and costs) would be developed for <u>one</u> storage goal (i.e., 80 million gallons, based upon a preliminary review of flow versus water demand conditions during 2002). Subsequent to that decision, the Planning Unit also requested that analyses be conducted to determine the amount of storage that would be required under various "flow versus need" (or, "what if") scenarios. It was understood at the time this request was made that the analysis of specific storage options and costs would not be expanded to incorporate the findings from these additional analyses (i.e., this was not included in the scope of work).

The "what if" scenarios were developed to provide an estimate as to the magnitude of additional storage that would be needed if the Big Quilcene River was managed in certain ways (e.g., with instream flow requirements being increased, or with no diversions being allowed during a certain time period). The scenarios are based in large part upon specific assumptions (e.g., an instream flow requirement of 30 cfs, no City/PTPC diversions during Sept-Oct), since no specific management objectives have been defined. As such, the scenarios are purely hypothetical. The amount of required storage identified by the scenarios (e.g., greater than 1 billion gallons for the "no City/PTPC diversions during Sept-Oct" scenario) is much larger than the amount upon which the specific storage options were based (80 million gallons), and is likely impractical. Therefore, development of cost estimates for specific facilities aimed at addressing the needs identified by the scenarios, prior to the solidifying of management objectives, would be a premature effort. However, a sense for the magnitude of cost for such facilities may be obtained by applying the unit costs developed for the evaluated storage options in Section 10 to the storage needs identified by the "what if" scenarios.

Additional text has been added in Sections 4.4.3 and 10.3.1 to clarify this distinction between the "what if" scenario analyses and the evaluation of specific storage options and costs.

4.2.1 City Demand
The City currently has a population of approximately 8,455 (Washington State Office of Financial Management estimate, April 2002). Projections for future water use to year 2046 are presented in the City's Water System Plan. This information is provided in Exhibit 4-1. Actual population growth for the City has been less than that anticipated by the 1998 Water System Plan. Per capita water use has also been reduced since 1995. Current average day water demand (ADD) is approximately 1.0 mgd, and the peak day demand (PDD) is approximately 2.2mgd.

Deleted: *20*

Text was revised, per comment.

Exhibit 4-2
The table below represents a much longer period of record regarding "typical" river flow about the diversion. The numbers include USGS streamflow data collected at the diversion since 1994 and was prepared by John Orsborn for the Environmental Assessment for the City of Port Townsend's Special Use Permit Renewal (2003). USGS records in the 1970's took measurements near the community of Quilcene, well downstream of the diversion and did not take into consideration water diverted.

Table 3-1. Average Monthly Natural Flows (cfs) (modeled flows without diversion) for the Big Quilcene River below the Diversion and at Highway 101.

	Big Quilcene River Below Diversion			Big Quilcene River at Highway 101		
	Average Annual Flow: 165 cfs			Average Annual Flow: 200 cfs		
Month	Maximum	Mean	Minimum	Maximum	Mean	Minimum
Oct	267	94	24	332	117	29
Nov	416	180	38	521	222	44
Dec	581	245	77	700	296	94
Jan	588	251	53	689	296	63
Feb	492	224	54	583	266	64
Mar	375	178	66	443	210	79
Apr	310	177	94	365	210	112
May	370	204	101	452	250	126
Jun	334	175	78	417	220	98
Jul	228	101	41	284	128	51
Aug	115	56	25	144	70	31
Sep	128	46	21	159	57	26

Source: Orsborn, unpublished data, 3/12/2003.

This table of data was added to Section 4.4.1, with text explaining that it should be considered as a part of future analyses. This data was not, however, used in the analyses presented in this report, as this effort was outside the scope of work amendment (Attachment A-1) directing the latest revision work.

Exhibit 4-3
Change the caption "Storage volume needed to satisfy ~~current~~ needs in 2002 = 610 MG)1,875 AF)".

Caption revised, per comment.

Exhibit 4-4
For the hypothetical situation of maintaining 30 cfs instream it would make more sense to use average stream flows from the table above instead of 2002 low flows.

See response to Exhibit 4-2 comment (regarding use of new data).

Exhibit 4-5
See comments for Exhibit 4-2.

See response to Exhibit 4-2 comment (regarding use of new data).

6.2.1
This reflects the debate over the extent to which conservation can continue to have some effects and increasing population growth.

Text was revised to convey the concept that demand will continue to increase due to population growth, even though conservation may decrease per capita water use.

6.2.2
The only potential significant user of this supply is the City's golf course.

Text revised, per comment.

7.1
Depending on the amount of ground water, this conjunctive use could allow for more surface water to remain in the rivers to maintain instream flows during "surplus" years.
Do you mean during the low flow time of the year?

Yes; the text was revised to clarify this.

Does the annual operating cost for providing ground water to Port Townsend include the cost for pumping the water from the Tri-Are to Port Townsend?

Annual operating costs were revised to include costs for pumping ground water from the Tri-Area to Port Townsend, primarily including costs related to power.

9.1 Operation of the OGWS
After leaving City Lake, the water is screened and chlorinated. Because of water quality regulations (chlorine contact time (CT)) water that enters the City system flows to the two reservoirs prior to being supplied to any customers. Water flowing to PTPC does not go through the City's reservoirs but meets minimum CT requirements.

Deleted: *and does not meet*

Text revised, per comment.

9.3 Costs/Benefits
Costs for the modifications to the control valves and installation of telemetry for the valve and meters are small compared to the capital costs for new storage. The new valve is estimated to cost $25,000 including telemetry, power operation, and the other required fittings to install it into the existing pipeline. Installation of telemetry for five meters and the two lakes is estimated at $100,000.

Where are the five meters? Both the inflow and out flow meters for City Lake are currently connected to the SCADA system, however the valves are not remotely controllable.

The costs for meter telemetry were removed. They were initially included as it was earlier understood that the meters were not connected to the SCADA system. Now, the only cost described in this section is for the installation and telemetry of the new valve.

Benefits from installation of the valves and telemetry are primarily realized by the operations personnel who manage the pipeline. They will have to travel less to take meter readings, ~~and will~~ have better information on the operation of the pipeline~~. The~~ and the reservoir~~s~~ ~~will be maintained in a full condition~~

~~for a longer period of time and the operators will be able to start the low river flow period with full reservoirs~~ levels will be easier to maintain.

Text revised, per comment and to account for the removal of the need for meter telemetry.

~~The amount of overflow from Lords Lake, back into the Little Quilcene River will be decreased.~~ However, having the new valves and telemetry will not assist in providing additional water during periods of low flow in the rivers. The primary benefit is accrued during the higher flow periods with less flow in the pipe and more remaining in the rivers (i.e., available for maintaining higher instream flows)~~, and the fact that there will be greater certainty that reservoirs will be full during the start of the dry period~~.
Lords Lake is intentionally overflowed to maintain water quality in the reservoir. It is not difficult to maintain a full reservoir prior to drawing from it during the low flow period.

Text revised per comment.

10.3.1
There should be consideration of storage requirements for the other "stream flow management options" including, maintenance of 30 cfs instream flows (an additional 100 MG above that in figure 4-3) and no diversions between September 1 and November 1 (a total storage need of 1290 MG).

See response to third comment, regarding this topic.

10.4.2
CDM concluded that both expansion alternatives were not feasible due to difficulties with filling the enlarged reservoir~~, seismic concerns, etc~~. However, a smaller expansion may be feasible. Based upon Lords Lake's present capacity of 1,660 ac-ft, a 16 percent expansion would meet the target storage expansion goal of 80 MG.

Text revised, per comment.

The expansion goals should encompass the range of storage considerations. See comment for 10.3.1.
10.4.3
The expansion goals should encompass the range of storage considerations. See comment for 10.3.1.

10.4.4
The expansion goals should encompass the range of storage considerations. See comment for 10.3.1.

10.4.6
The expansion goals should encompass the range of storage considerations. See comment for 10.3.1.

Table 10-1
The summary of storage options should include a range of storage size considered; see 10.3.1, as well as a range of cost for the size of storage.

See response to third comment, regarding this topic.

10.6
On channel storage, particularly for the Big Quilcene River option, would require a substantial additional storage due to the amount of sediment transported by the river during winter storms.

Text was added in this section to describe this issue.

An expanded City Lake would be beneficial to the City and PTPC~~, but it is unlikely that additional stored water at this location would~~ and could possibly benefit other downstream water users or interest groups.

~~Even so, there have been periods in recent years where any additional storage in the OGWS system would have been beneficial.~~

Text revised, per comment.

II. Comments/Clarifications from the Mill

Section 6.3.3 Conservation/Reuse, Table 6-1

Under "Recent and Impending Changes"
The "B" side washing shutdown did not happen. It should be removed together with the –1.50 decrease in flows.

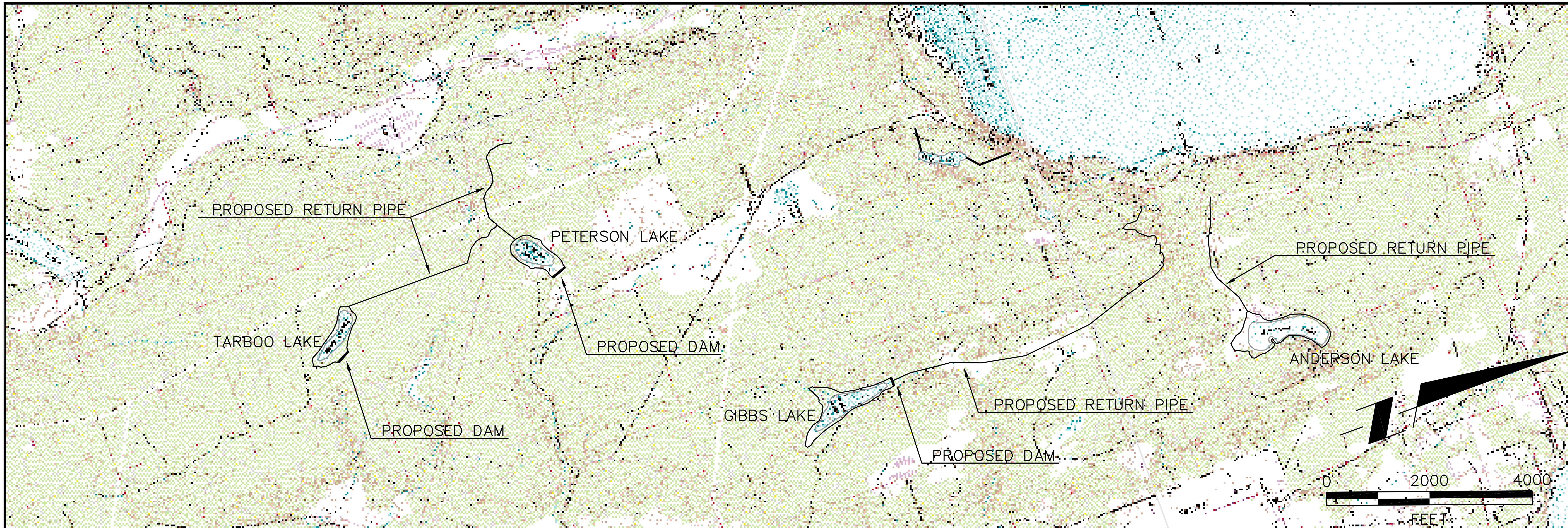
Table revised, per comment.

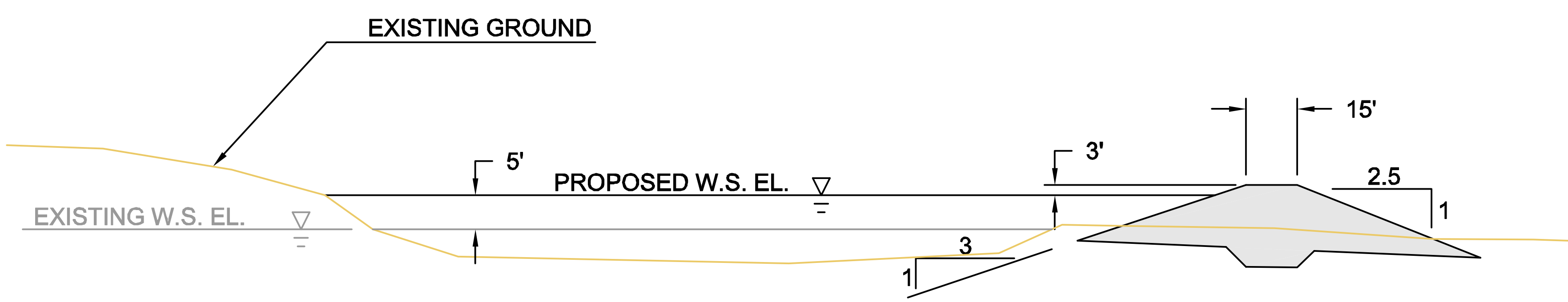
Under "Other Conservation Opportunities"
Move Chemical Pulp mill shutdown to the last item since it is not at all likely that this will happen.

Table revised, per comment.

In the paragraph following Table 6-1, change the last sentence as follows:
Total ~~Costs~~ costs for ~~each of~~ the other conservation activities is estimated to be on the order of ~~$100, 000,~~ $400,000.00 according to PTPC staff.

Text revised, per comment.





TYPICAL SECTION

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N. Dieterich 6/18/03 1006/figures 1-7/Exhibits 1-7.dwg

June 20, 2003

Exhibit 10–6

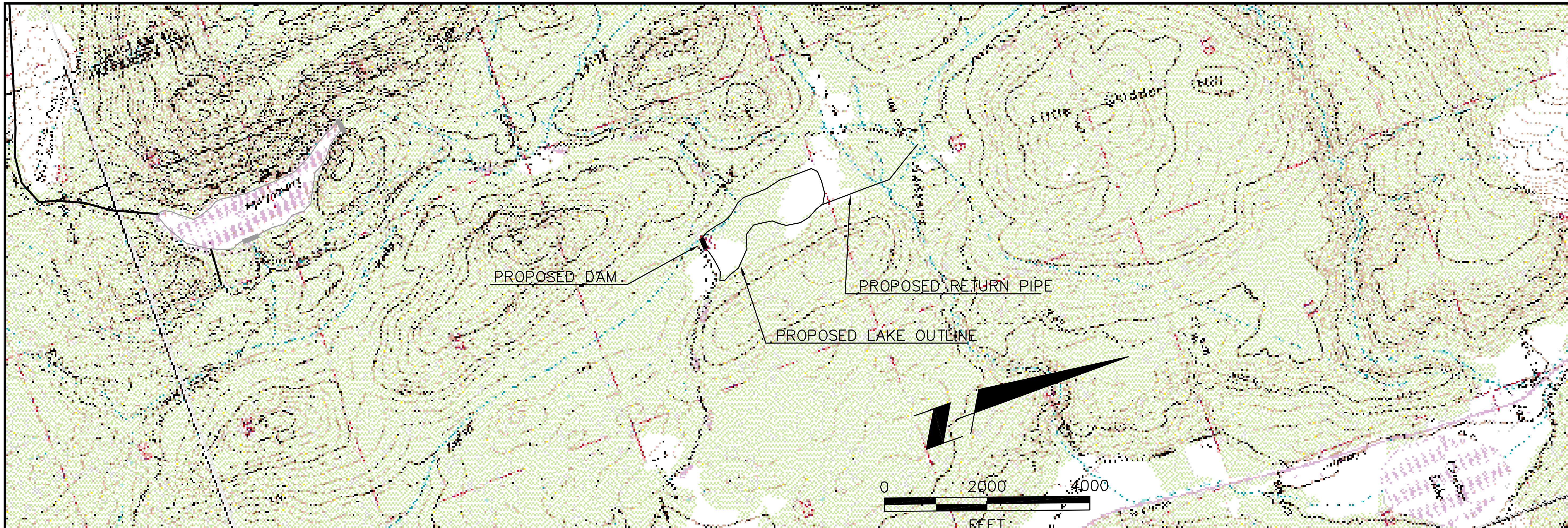
Jefferson County WRIA 17

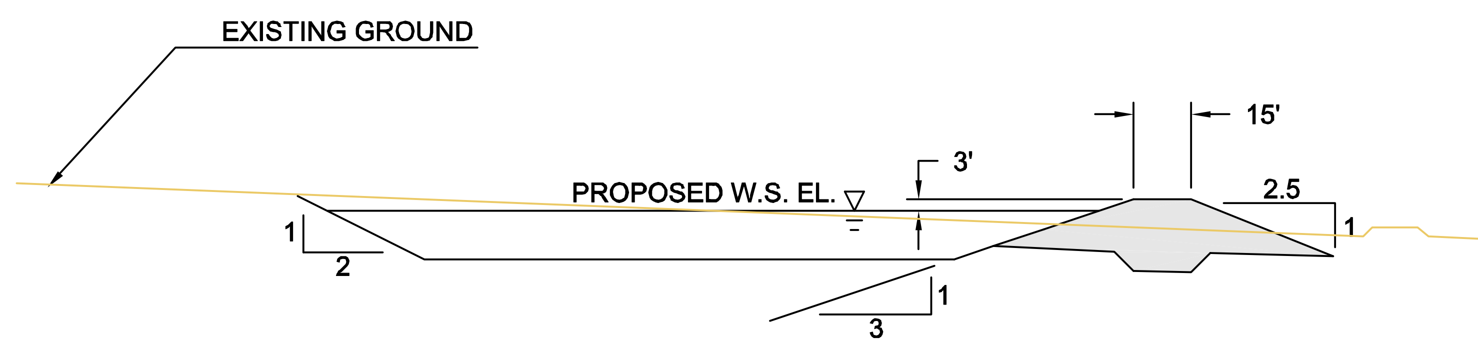
Natural Lakes Alternative

Surface Water Offset Storage Evaluation

MONTGOMERY WATER GROUP, INC.

N. Dieterich 6/18/03 1006/figures 1-7/Exhibits 1-7.dwg





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June 20, 2003

Exhibit 10–5

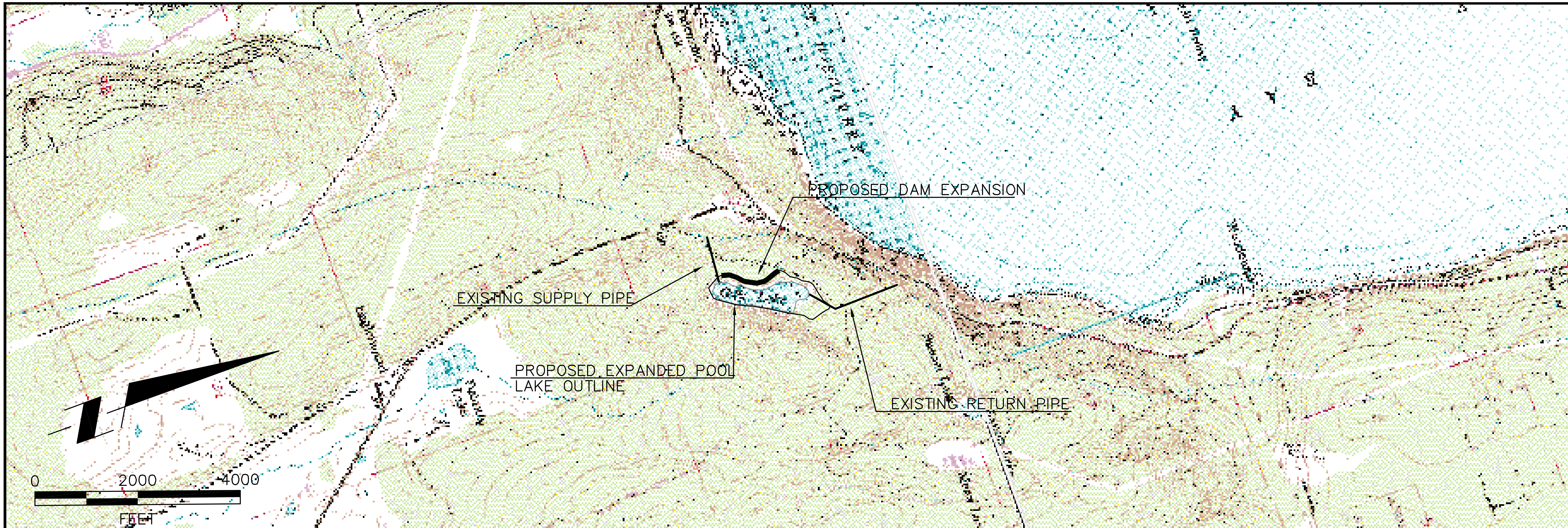
Jefferson County WRIA 17

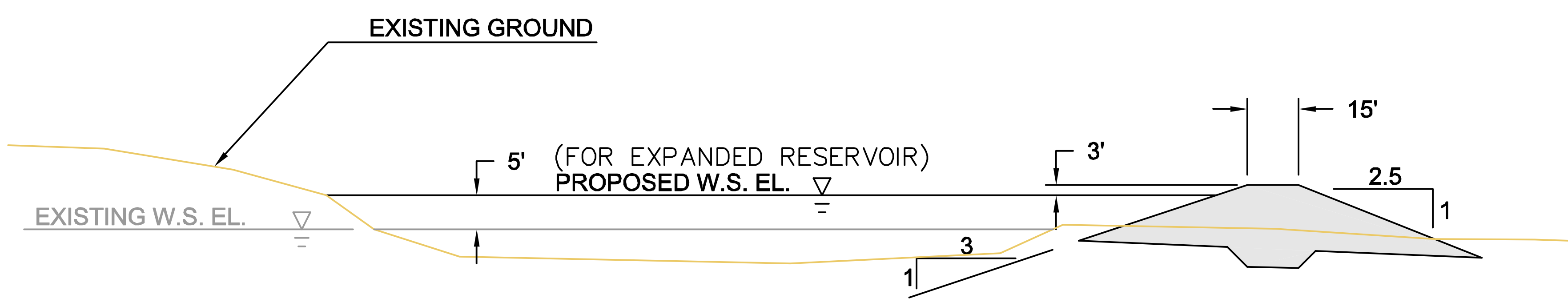
Excavated Storage Alternative

Surface Water Offset Storage Evaluation

MONTGOMERY WATER GROUP, INC.

N. Dieterich 6/18/03 1006/figures 1-7/Exhibits 1-7.dwg





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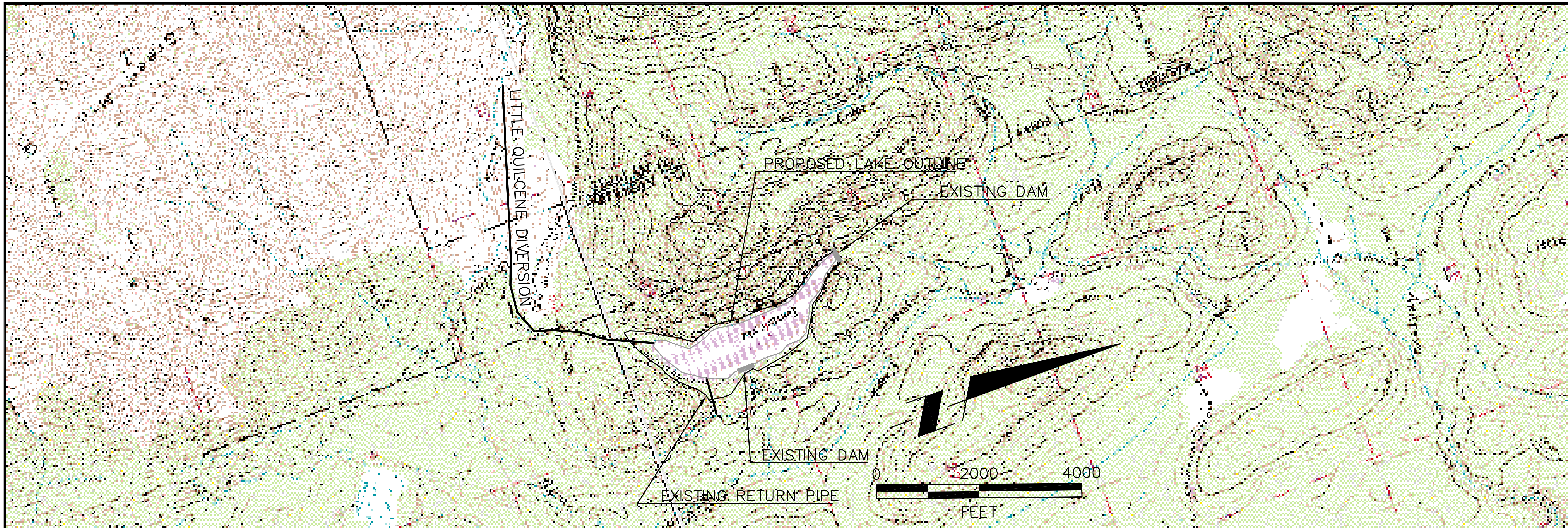
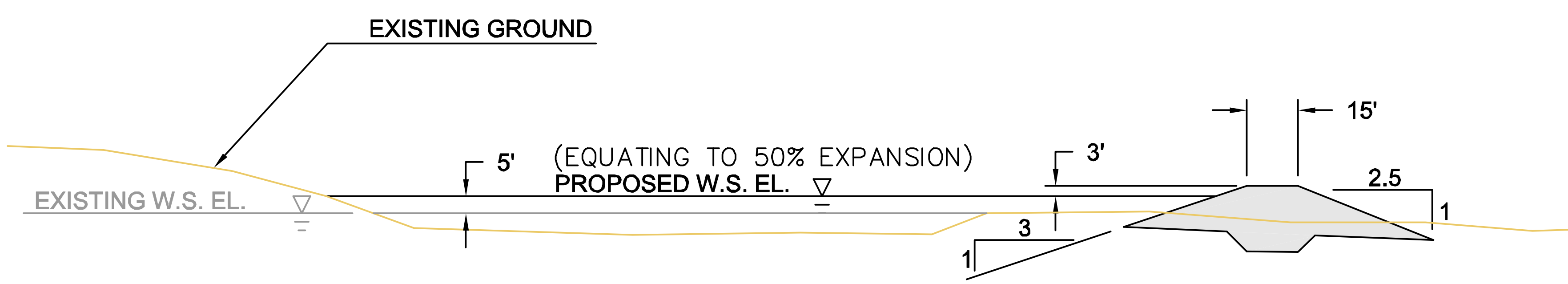
June 20, 2003

Exhibit 10–4
Jefferson County WRIA 17
City Lake Alternative

Surface Water Offset Storage Evaluation

MONTGOMERY WATER GROUP, INC.





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June 20, 2003

Exhibit 10–3
Jefferson County WRIA 17
Lords Lake Alternative

Surface Water Offset Storage Evaluation

MONTGOMERY WATER GROUP, INC.

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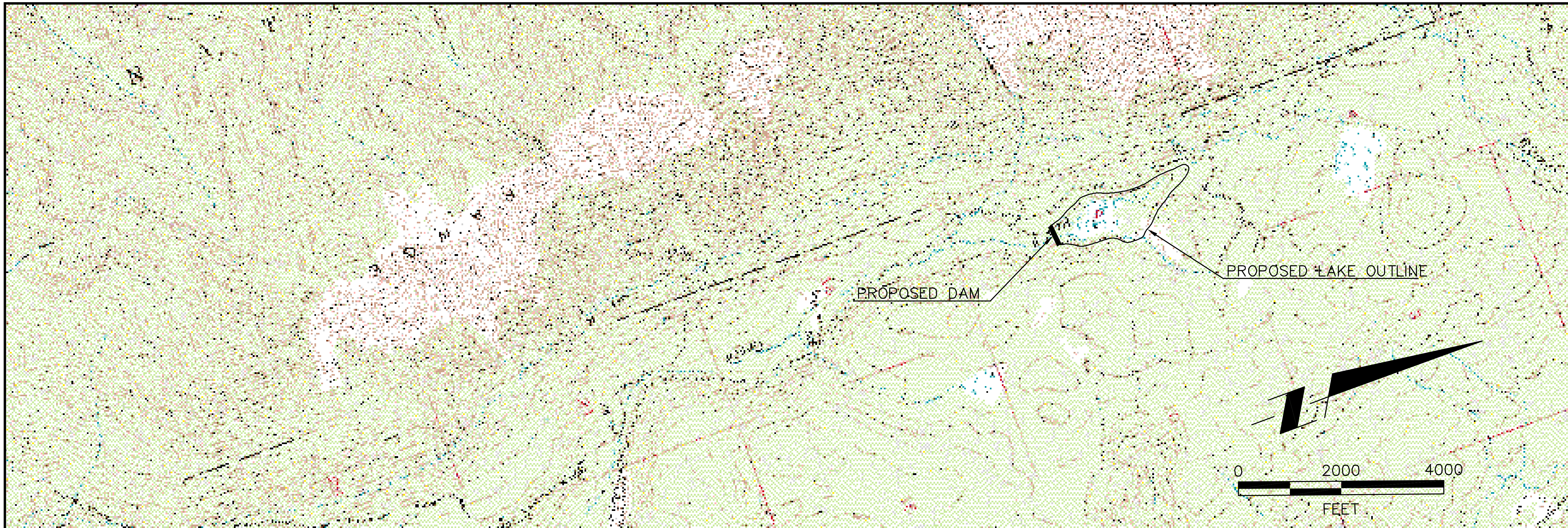

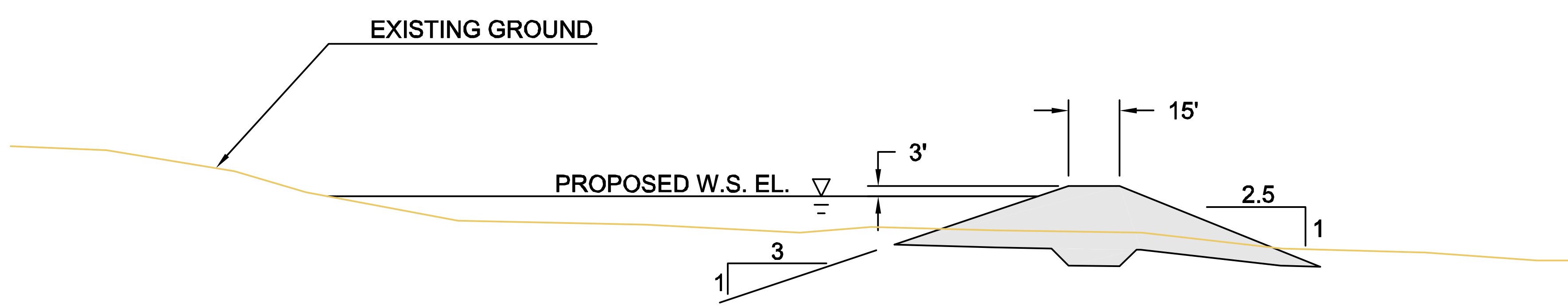

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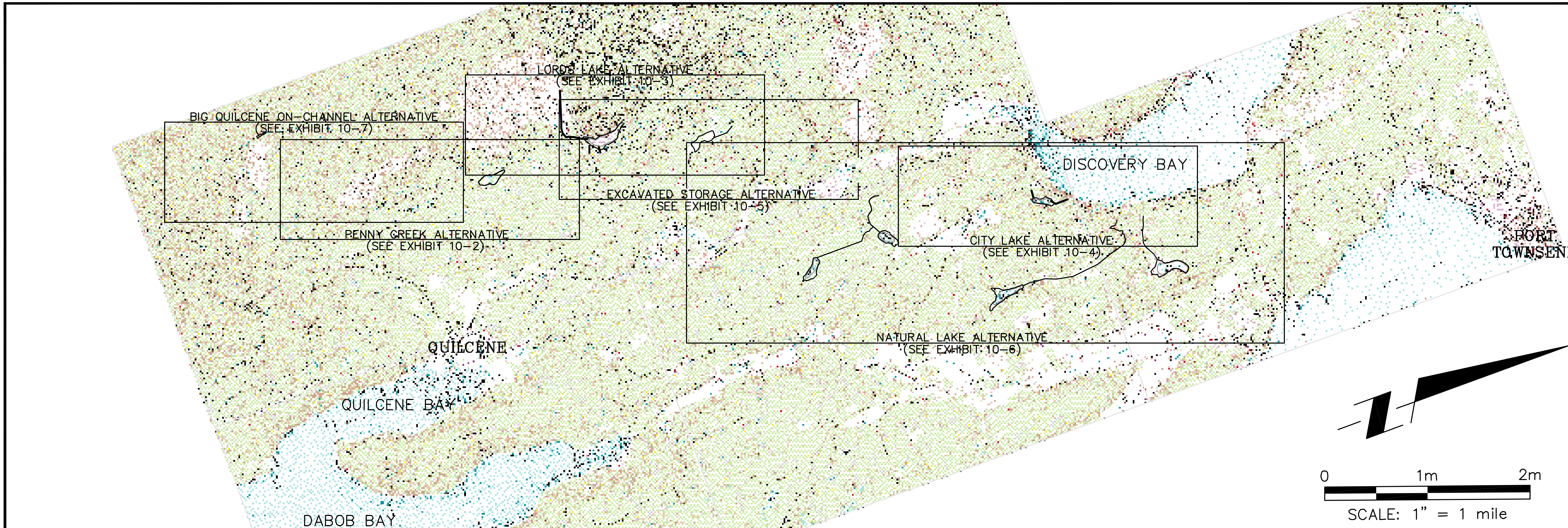
June 20, 2003

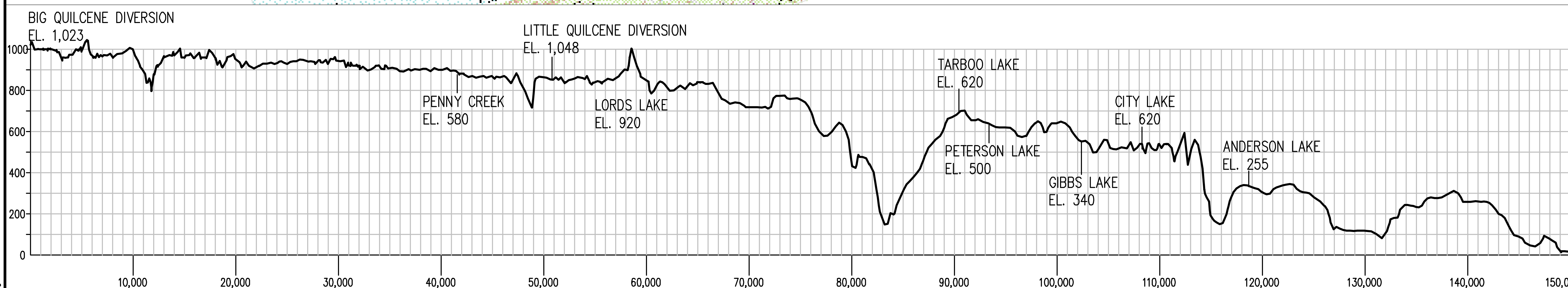
Exhibit 10–2
Jefferson County WRIA 17
Penny Creek Alternative

Surface Water Offset Storage Evaluation

MONTGOMERY WATER GROUP, INC.

N. Dieterich 6/18/03 1006/figures 1-7/Exhibits 1-7.dwg





PROFILE

HORIZONTAL SCALE: 1" = 10,000'
VERTICAL SCALE: 1" = 500'

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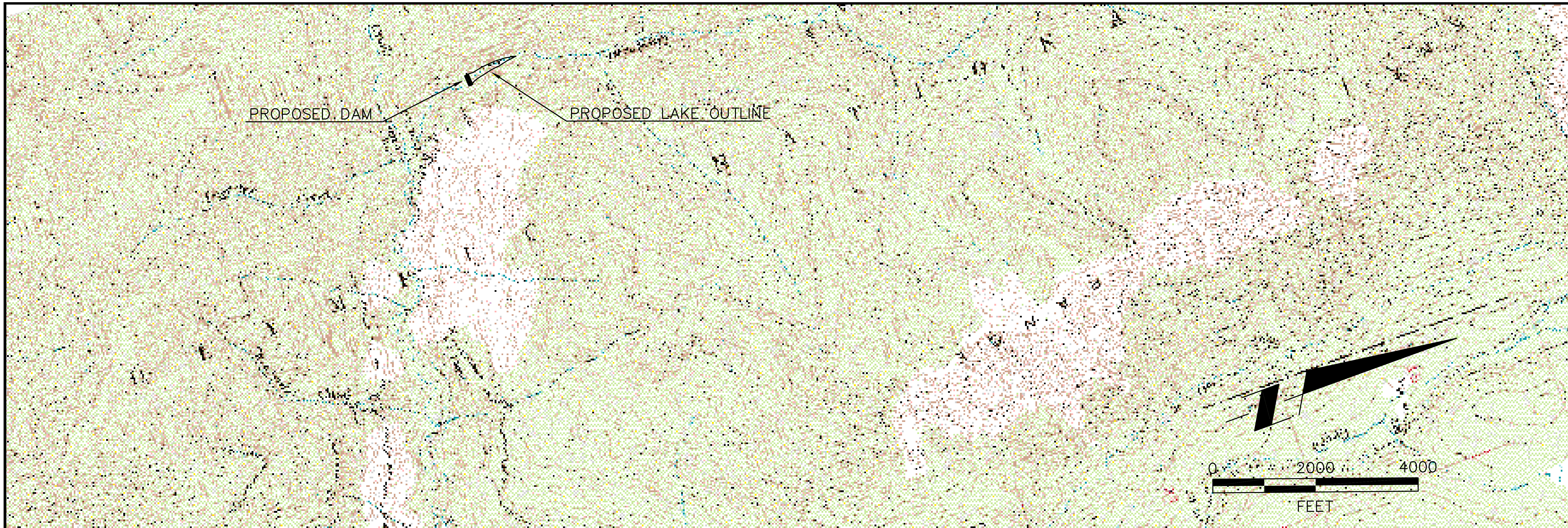
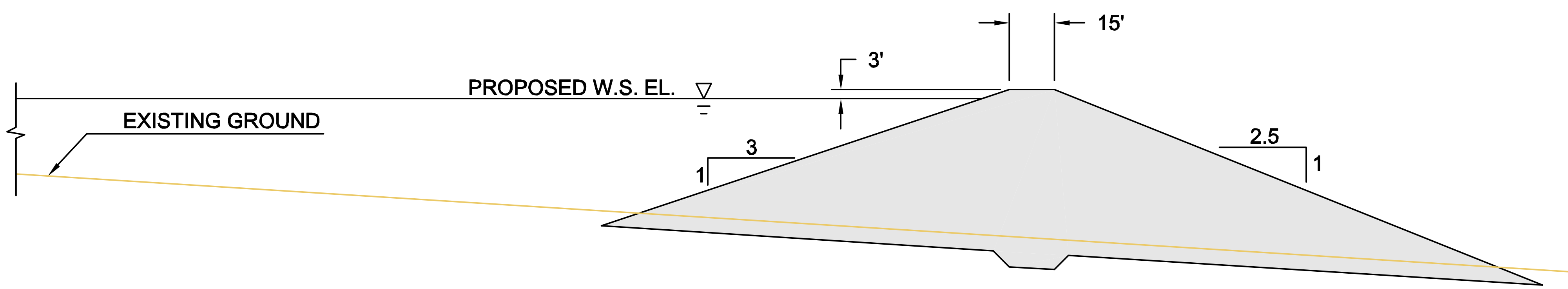
Exhibit 10–1
Jefferson County WRIA 17
Site Alternative Map

Surface Water Offset Storage Evaluation

MONTGOMERY WATER GROUP, INC.





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June 20, 2003

Exhibit 10–7
Jefferson County WRIA 17
Big Quilcene On–Cahnnel Alternative
Surface Water Offset Storage Evaluation

MONTGOMERY WATER GROUP, INC.

N. Dieterich 6/18/03 1006/figures 1-7/Exhibits 1-7.dwg